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LIGHTNING AT PLAY.

The city of New York, on Sunday, August 13, was visited by what to this locality was an unusual electric storm. Various points were struck and a number of injuries to persons resulted. Three electric cars were damaged, the elevated structure was hit at one point and other unusual pranks were played. It is interesting to note that although one of the cars struck was somewhat damaged and put out of service, that the injuries of the passengers were due to a secondary result. In the confusion which perhaps naturally arose when the flash of lightning made its terrifying demonstration about the car, many of the passengers lost their heads and jumped from the rapidly moving vehicle. The only injury due directly to the lightning was that to the motorman who was somewhat burned, presumably by a flash from the controller; all the others were cuts and bruises from jumping. At another point, one person was killed and several somewhat injured by a flash of lightning which struck a bath-house. At such an unusual display the total damage done was less than might have been expected, but emphasizes the fact that we have not yet reached immunity from lightning. We feel that we know a good deal about it, but it is not yet harnessed as it should be. Somewhat significant at this time is the announcement that the Lightning Research Committee of the National Electric Light Association will be continued, and valuable information will, it is hoped, be added to that which already has been collected. But as this committee devotes its thoughts to electrical systems, would it not be well for some association interested in lightning protection, in general, to investigate the subject in a broader way. There is in Great Britain a lightning research committee which has a field somewhat of this kind.

THE TENDENCY OF TELEPHONE DEVELOPMENT.

At the recent convention of the National Interstate Telephone Association held in Chicago, a paper was presented by Mr. Edward E. Clement, which discussed the development and future tendencies of the telephone art. An abstract of this paper may be found on another page of this issue.

Mr. Clement reviews briefly the different stages of telephone development. The first stage extends from 1876 to 1880. The telephone had just been invented and was exceedingly crude, and much work was necessary before it could be of any value. This period is chiefly of historic interest. There was almost no business done, though much important work carried out during the next period was foreshadowed.

The second period extended from 1880 to 1890. This was the period of the practical man and deserves the credit for the production and development of some of the most important features of our present telephone systems. During this period the multiple switchboard was introduced and underground wires were first used for telephone communications.

The third period begins in 1890, when the art of telephone engineering was born. Telephony was wonderfully improved by the skilled men who gave their energy and ability to the work, and at the end of this period, twenty-four years after its invention, the art of telephony, according to Mr. Clement, reached its maturity. Apparatus had become standardized, as had also the system used in all large important installations in this country. In smaller and less important places, naturally some of the older methods still prevail. In the present period beginning 1900, the telephone engineer has not the freedom which previously obtained. He must conform to certain standards and he must provide for various services which the public has come to demand. He has, however, a pretty wide field for

growth. It is during this period that the most promising attempts to increase the distance of telephone communication have been made, and during this time also automatic systems have pushed forward and now demand a hearing. Probably the question which is uppermost in the minds of many telephone engineers is, what part will automatic telephony play in the systems of the future?

There are several types of automatic telephone systems designed by their inventors to meet different problems, but the question confronting the operating man is, will automatic telephony reduce the cost of operation without injuring or restricting the service? Mr. Clement does not think that either automatic or manual apparatus will be used exclusively.

The belief that certain advantages of the automatic system might be secured to the manual system, has led to the so-called semi-automatic systems. In some of these an attempt is made to transfer part of the work of securing connection to the subscriber. In one system the subscriber sets up the number wanted on a mechanical device at the exchange instead of calling it to the operator. In another the operator connects the subscriber to a trunk which leads to an automatic switch. The subscriber himself completes the connection. In another, the automatic application is merely for disconnecting lines as soon as the subscribers are through. In still another semi-automatic system a switch is employed which selects an idle operator. Otherwise the system is essentially manual. This would seem to promise well, for it retains the present excellent manual systems and does not throw any of the burden of making connections on the subscriber, nor at the exchange does it increase the labor of the operator. It would seem that its use will facilitate considerably making a call since the taking down of the receiver automatically connects the subscriber with an operator who is not busy and who can immediately make connections. Moreover, it automatically distributes the calls as they come in so that an operator receives them only as fast as she can take care of them. It would seem that such a system would considerably reduce the force of operators required at any exchange, since it allows each to work most efficiently.

STEEL TOWERS FOR TRANSMISSION LINES.

Much has been said in an informal way about the use of steel towers in place of wooden poles for transmission lines, but, so far as we know, no one up to the present time has discussed this new departure in transmission practice critically. On another page of this issue, Mr. Alton D. Adams considers the use of steel towers, noting the principal instances in which they have been adopted, estimating the cost of the towers, and finally comparing the steel towers with the old wooden poles.

The conclusions drawn by Mr. Adams are unfavorable to the steel towers for general purposes. He finds that they cost more and entail certain disadvantages. It is estimated that they will act somewhat as a protective during thunder-storms, but it is not thought that they are any better for this purpose than the protective devices generally adopted on important wooden pole lines. On the other hand they present a possibility which may be serious. A possible accident on a transmission line is the breaking of an insulator by lightning or a rifle bullet. When this happens on a wooden pole the conductor is dropped clear of the pole or catches on a cross-arm. In the first case the line is not generally thrown out of service. In the latter case the cross-arm may support the conductor without being damaged, or the latter may burn off the arm. But in neither case is the line necessarily put out of service. The breaking of an insulator on a steel tower, however, might and probably would be more serious. If the line dropped upon the tower or even swung against it at the side, it is probable that an arc would be formed and the conductor might be burnt in two before the line could be disconnected at the station. Such a happening would not only put the line out of service, but would be somewhat troublesome to repair. In this feature the wooden pole seems superior to the steel tower.

Should, however, the dropped line fall clear of the tower, it might become a menace to the neighborhood. Usually, steel towers are employed with longer spans and the elimination of one point of support might allow the conductors to approach dangerously near to the ground. It seems that the use of steel towers will make necessary certain precautions to prevent the wire from falling away from the tower or from coming in contact with the metal. Of course, in most stations there are circuit-breakers for protecting the lines and it is probably that these would prevent the burning in two of the conductor, but they would not enable the line to be kept in service after the breaking of an insulator or a pin.

So far we have been considering the advantages of the steel tower as compared with the wooden pole only with regard to electrical troubles; but there are other troubles generally more serious and more likely to occur than those mentioned. The worst enemy of overhead electric lines for whatever purpose they are used is storms. In fact, the pole line is to-day the most uncertain part of our electric systems. However well we have built the past, we have not been immuned from storms. Almost every winter some large section of the country is cut off from the rest of the world by an unusually severe storm. In Great Britain and in Germany this trouble is avoided in some degree by means of underground lines. But underground lines are out of the question in this country except for very important connections. If the steel tower proves to be better able to meet such unusual conditions, the additional cost will frequently be warranted. It is vitally important for a large transmission system to preserve an absolute continuity of service, and to this end steel towers help. Viewed in this way as an insurance against mishap to the weakest part of the system, the steel towers become not only allowable, but almost necessary. But in each case the question must be considered carefully and in many cases, probably in all small plants, the wooden pole will, as Mr. Adams points out, persist. Probably heavier poles will be used and possibly composite built-up poles or wooden towers, but the material used will be wood and not iron.

GERMAN ELECTRICAL SYSTEMS.

In a recent issue of the *Elektrotechniche Zeitschrift,* Herr Fritz Hoppe discusses the financial results of certain German electricity supply systems. There are in Germany to-day 1,028 plants capable of supplying 530,946 kilowatts. The average investment is $325 per kilowatt, so that the total capital is about $175,000,000. Only about ten per cent of these plants publish the results of their operation.

Herr Hoppe's discussion is based upon the data obtained from 174 German companies; but 112 gave full reports. The capital invested per kilowatt varies from about $345 for the larger plants, rated at from 2,000 to 5,000 kilowatts, up to about $450 for the smaller plants, with outputs of 100 to 250 kilowatts. Four of the 112 stations publishing full reports are using water power and twenty-four are driven by gas engines. The latter are small stations, only one of them having an output of over 500 kilowatts.

Perhaps the most interesting part of this article is that dealing with the cost of operating these German plants. The cost of running the plants varies from six to seven per cent of the total capital invested, about one-third of this being for coal and one-third for labor. The average cost of each kilowatt-hour sold varies from 2.4 cents for the largest stations for an output of over 2,000 kilowatts to 3.8 cents for the smaller stations. It should be mentioned that this list includes a number of very small stations, with equipments of less than 100 kilowatts, for which the investment and cost of operating are, of course, much greater in proportion. Nineteen of the stations sold their product at more than fifteen cents per kilowatt-hour for lighting; eighty-eight charged fifteen cents per kilowatt-hour; fifty stations charged less than fifteen cents. For power, sixty-four stations charged twelve cents per kilowatt-hour; sixty-four charged less than this and thirty-three charged more. The system of charging most used is a flat rate with discounts according to the consumption. The total receipts amount to about twenty per cent of the capital for the larger stations and drops to about half of it for the very small stations.

From the above figures is seen that the difference between receipts and the cost of operating the station is on an average about 8.3 per cent of the capital invested, which Herr Hoppe thinks is inadequate for meeting depreciation, interest and maintenance charges. The author thinks that this unfavorable result is due to several causes. Some stations sell power at less than it costs them to generate. Others have spent too large a capital and in still others a lack of judgment has led to the installation of too large a plant. These results are interesting in view of the discussion of charges for electric power which was going on so vigorously in this country a short while ago. It is also interesting in view of the criticisms made from time to time of American engineering methods. We are told that we do not pay sufficient attention to decorative features. Foreign engineers are particularly fond of comparing our practice in this matter with that which obtains in Germany. On another point also experience in this country has been different from that abroad, in spite of the prevailing idea of our love for bigness. Generally speaking, electrical supply stations in this country find that instead of being too large, their equipment is too small, and frequently contracts for additions are let before the first part of the plant is in operation.

THE WIRELESS TELEGRAPH INDUSTRY IN GREAT BRITAIN.

A parliamentary paper issued recently gives an account of the wireless telegraph industry in Great Britain for the first three months of the current year, and shows an interesting condition of affairs. As is well realized, the principal use, in fact the almost exclusive use, of wireless telegraphy made by the public is for transmitting messages between ships and the shore; but few, perhaps, realize how one-sided this transmission is. The report shows that there were but 111 messages submitted by the public for transmission to ships at sea during the period mentioned, while there were 1,655 messages received from ships at sea. Moreover, of the former lot of messages, twenty-one failed of delivery, leaving only ninety messages transmitted to sea, a little less than 5.5 per cent of the number transmitted in the opposite direction. The reason for this lies probably in the fact that the public has not yet accepted wireless telegraphy as a public utility. The busy man at home rarely thinks of sending a message out to sea, while those on shipboard have the apparatus always before them, and are always seeking for new diversions. The British post office collected about $275 for outgoing messages and received about $325 for its share of the incoming messages. The Marconi Company received for the messages sent out by its land station, about $237. It is estimated that at the same proportion the total income of the Marconi Company for messages sent in both ways for the entire year would not be more than $9,000. Evidently some method of increasing business is necessary if this system is to be put on a profitable basis.

The second part of the report deals with the developments now going on in Great Britain. Seventy-three applications have been made and forty-eight permits have been given for the erection of wireless telegraph stations. Most of these are for experimental purposes. Ten only are for commercial use. The stations are pretty well scattered over the British Isles, and there are no less than twenty-four companies or individuals conducting wireless telegraphic work. The greater part of this will be comparatively on a small scale, though two or three stations will be powerful. Four will attempt trans-Atlantic communication. With all of this work going on, considerable progress ought to be made and a good deal of information gained with regard to practicable operation of such systems and the effect of interference. Figures are not available showing the condition of wireless telegraphy in this and other countries, but in the United States, Germany, France and Italy active and energetic men are devoting all of their efforts to perfecting various systems from which work we may expect considerable progress.

DEVELOPMENT AND FUTURE TENDENCIES OF THE TELEPHONE ART.[1]

BY EDWARD E. CLEMENT.

The development of the telephone art as such has now extended over a period of thirty years, which, for purposes of comparison, divides itself into several distinct periods. In the first, extending from 1876 to 1880, the known art began with a wire running from one end to the other of Machinery Hall at the Centennial in Philadelphia, with a very crude magnetic telephone, such as we now call a receiver, at either end. During the five years that followed, the microphone was produced, the switchboard was born, and the forerunners of modern operating methods were evolved. This period was of historical interest only, a significant fact, however, being that almost every important departure of the next decade was then foreshadowed. There were no telephone engineers, the amount of business was too infinitesimal to permit the training of men, and so the first apparatus was rude and cheap, and in perfect keeping with the methods of operating, wherein the subscribers' operators shouted directions, or sent tickets around by boys.

The second period extended from 1880 to 1890. This was full of rich and interesting developments, and may be spoken of as the time of mechanical signals and magneto currents, or the local-battery period. In the earlier days, and, in fact, in some of the very first installations, batteries at the central office were employed for talking and signaling, but the primary battery, being then the only source commercially available, the magneto generator was adopted of necessity to signal with certainty over the gradually lengthening lines, and the talking battery was put at the substation, where, with an induction coil, the efficiency was incomparably higher than when working through the line resistance.

The greatest and most significant feature of the local-battery period was the development and introduction of the multiple switchboard. This was rendered possible by the invention of the Warner spring-jack, and in part by that of the tubular-drop annunciator. Test circuits were worked out to such an extent that it is even now hardly possible to find or utilize a change in conditions for testing which was not thought of and tried before 1890 in some shape or form. The self-restoring annunciator came as a necessary and inevitable corollary, the best and simplest form having a heavy block held up by a hook on the end of a rod carried by the armature, and acting when released by falling forward and raising a thin aluminum shutter to uncover the number. When itself attracted, by the energization of the restoring magnet, the heavy block was pulled in and the aluminum dropped.

It was during this period also that the first serious attempts were made to lay cable underground, and in saying this I do not forget that the use of the lead-covered conductor goes back to the first telegraph line ever built. Morse and Vail dropped their lead pipe in the ground behind a plow, however, and it got punctured, so they ripped the lead pipe off and put the wire overhead, after all.

It is correct to say that by 1890 the art of telephone engineering had been born, and Bell or no Bell, the men who made that possible, by giving their best years and their best energies to the work, deserve to be honored for the thoroughness with which they wrought, and the safe foundation they have given us upon which to build the magnificent superstructure of modern telephony. Many of them, like J. J. Carty, are still in the harness, and some of them are connected with independent enterprises.

In the decade beginning with 1891 what I may call relay control came in. The common-battery system superseded the old magneto, or made great strides toward doing so, and what I have called the mechanical signal began to be replaced by the incandescent lamp. This latter was first used in Chicago in 1890, in connection with the trunk lines, and it needed very little experience to determine its superiority over any other form of signal.

In the spring of 1893 it was proposed to reequip a large multiple board in the Chicago company's exchange with self-restoring drops, and the success of the lamps used for disconnect signals on the trunk lines caused it to be seriously considered, but it was not actually adopted until the Sabin "express board" was brought out in 1894. This board was designed, as its name indicates, to meet the wants of metallic-circuit subscribers whose telephonic business was large, and it was equipped throughout with lamp signals worked by relays energized by battery current controlled by the subscriber's hook. Nearly all the large boards built by the Bell people after 1895 were equipped in this way.

In the middle of this decade the Bell patents expired, soon followed by other fundamental patents, and the bars were at once thrown down for everyone who desired to get into the telephone field. I have tabulated the issue of telephone patents by subclasses since 1876, and this irruption of new blood does not seem to have been productive of a very marked increase in the number of inventions recorded. Allowing for the abnormal discharge of the Kellogg accumulation of over 100 patents in 1897, the increase appears to have followed systematic lines, although it is noticeable that the banner year up to 1904 was the year 1897, with 1896 a close second. A résumé of the patents granted each year may be of interest. In the five years from 1876 to 1880 there were 248 patents granted, of which 146 came out during the year 1880 alone, leaving only 102 for the first three years of the art, of which thirty were for microphone transmitters, and twenty-nine for receivers. In the year 1881 there were fifty-two transmitters and twenty-five receivers patented, and up to that time there had been twenty-four step-by-step devices for party lines already evolved and thirteen switchboards. From 1881 to 1885, 866 patents were issued, of which 306 were for transmitters and receivers, while about 100 were for switchboards. Taken year by year after that we find: 1886, 158; 1887, 107; 1888, 105; 1889, 70; 1890, 110; 1891, 70; 1892, 117; 1893, 145; 1894, 126; 1895, 160; 1896, 223; 1897, 259; 1898, 94; 1899, 132; 1900, 180; 1901, 193; 1902, 106; 1903, 188; 1904, 280; 1905, 74.

The increase in 1895, 1896 and 1897 is significant for this, that those matters which necessarily engrossed the immediate attention of the independents jumped in the number of patents to double or treble for these years. Thus it will be remembered that everyone was casting about for some way of making a good transmitter, that being a *sine qua non* for conducting telephone business. Accordingly we find that the number of granular transmitters suddenly jumped from six in 1893 to sixteen in 1894, twenty in 1895, twenty-eight in 1896, and nineteen in 1897. There have been eighty-four microphone patents granted since, of which twenty-five came out in 1904, which, for some reason, seems to have been a very productive year all along the line. The number of transmitters other than granular has been small, but I should say that over ninety per cent of all these patents have been issued to the independents.

The settling down of the independent engineers, or, perhaps, I had better say,

[1] Abstract of a paper prepared for the convention of the National Interstate Telephone Association in Chicago, Ill., on June 20-22, 1905. The author is a patent expert in Washington, D. C.

the settling down of the independent companies to the employment of engineers, did not come until near the close of the decade and of the century. As the movement solidified and it became apparent that there was no more danger of bankruptcy in the independent than in the Bell ranks, many superior men left the older companies, and as they brought their crystallized ideas of practice with them, they hastened the process of evolution which was already going on.

We may say, therefore, that with the year 1900 the entire practice of the art had arrived at maturity, and its features may be reliably determined. We find the subscriber's apparatus practically standardized. For all large plants this was, of course, common-battery type, without any generator or battery, depending upon the switch hook for signaling, just as it does to-day. For smaller installations and party lines the series and bridging magneto telephones were on practically uniform lines. I might here remark that, among other things, this decade produced the commercial bridging bell telephone, although its origin dated back into the earlier magneto period.

In passing into the present decade all engineers found themselves confronted in designing by the following requirements: common battery must be employed; multiple switchboards must be employed, with lamp signals, double supervisory signals, etc.; four-party selective service must be possible either on all lines or on a given proportion of the lines; pay-station and toll-line service must be provided for, and the operator's duties reduced to a minimum. The lock-out principle had been tried, but was generally discarded.

Another production of the lamp-signal period was the commercial automatic exchange, although its possibilities were denied most strenuously by the leading engineers, even after 1900. This, which had always been considered more or less chimerical, was made reasonably practicable through the efforts of a group of men who really deserve a great deal of credit. I refer to Messrs. Keith, Lundquist, Erickson, Dunham and others. The principles of this I would like to go into but time forbids. I will merely state briefly, therefore, that the automatic system of to-day, of whatever design, is substantially and essentially a transfer system. A subscriber's line, through its individual switch or through a switch momentarily appropriated to its use, is trunked to the thousands group required, thence to the hundreds group required, and thence is connected with the wanted individual line terminals in that group.

Since 1900, and in what I might call the modern period of telephony, we can not consider the art without giving serious study to the automatic. Its gravest defects so far have been that it fell short of meeting the requirements which I have mentioned in connection with the manual systems. It could not be worked with common battery, it could not give party-line service, and it would not permit the use of automatic pay stations. These defects, however, have apparently been remedied. Within the last year I have examined three different systems, all of which give common automatic service, two of them make party-line selective work profitable, and one of them includes means, not only for the ordinary pay-station operation, but more. According to this system, several nickels may be put in the box, and one call after another may be made. For each call the machine will test, and if the line wanted is idle, it will take one nickel; if the line is busy it will return it. After all the calls are made, and the proper nickels taken in, if there is any change the machine will return it.

I am bound to say that, while the common-battery feature above is perfectly practicable and has been commercially tried, the other features are still in experimental form.

The question in concrete form resolves itself into this: is automatic apparatus likely to be produced which will materially lower cost without restricting the classes of service, or shall we have only improvements in existing systems and apparatus. In other words, is it to be manual or automatic? I believe the answer to this is that neither manual nor automatic apparatus and systems will be used exclusively.

Adhering to the stated requirements of standard practice, we find that some principles of the automatic can be and, in fact, are being combined with manual systems. For instance, there have been evolved several plans for semi-automatic operation. According to one, the subscriber sets up the number wanted on a mechanical sending device, which is tripped and runs down when the operator plugs in at central. The impulses transmitted serve to set up guiding signals before the operators on a manual-transfer board, which is bad, because the service must be slowed down. According to another, incoming calls are distributed by automatic switches among the different operators, automatically selecting idle operators.

A number of different inventors have worked out schemes for doing this, the subject having been agitated for a number of years. There will be choice between different systems, and if they get into commercial use competition will doubtless perfect them. Just what percentage of increase in the number of lines an operator can handle will result from these arrangements is somewhat problematical, and they will not substantially reduce the cost of a switchboard unless this percentage is so high as to greatly reduce the number of multiples; and in that case it would appear that the present distribution of lines on a board is more than ordinarily faulty.

According to a third plan, the operator receives her calls direct on answering-jacks, as at present, and connects each calling line to a trunk leading to an automatic switch, which is controlled by the subscriber to complete the connection. This is my own plan, for which patents were granted some years ago. By its use the number of lines an operator can handle is greatly increased and the cost of installation and maintenance, as well as of operation, are greatly reduced, since the switches take the place of the multiple jacks. This plan can be applied to existing switchboards without changing their circuits, retains all their advantageous features, such as double supervision, and gives the possibility of raising a human operator at central if things go wrong. The worst feature of the full automatic system is that if you can not work the machine you are hung up, and can only go to another telephone.

Another semi-automatic plan has recently been mentioned by Mr. Dean, and I have no doubt will be adopted by many companies. It does not change existing common-battery manual equipment, but has for its object to disconnect lines the instant the connected subscribers have hung up, thereby leaving both of them free to make fresh calls without delay. The method adopted makes no change whatever in the switchboard equipment, and adds very little in the way of apparatus.

So far I have referred only to improvements at the central office. The subscriber's station, in my judgment, will not be changed materially. In point of design, workmanship and materials, some of the telephone instruments put out this year are almost beyond criticism, and

while there will doubtless be a normal progression, it will not amount to radical change.

With regard to the cable plant, and long-distance and toll lines, there are several problems to be met, but the solutions are not yet announced. The possibility of bringing a long-distance line through-cable into or through a city without serious loss of efficiency is to be considered. According to the Pupin-Cambell method of the Bell people, a system of inductance sources is introduced into the cable, tapered so as to lessen the liability to reflection. So far the independents have nothing like this, although several schemes have appeared on paper; but it is probable that a working design will soon be announced.

Until the long-distance connections among our independent companies are more nearly complete we will not be interested in repeaters or telephonic relays, but these also must come, and within the last few weeks a patent has been issued to the Bell people for a repeater which will work on composite circuits. This means New York and Chicago and beyond.

Niagara Power Company Sold.

The control of the Niagara, Lockport & Ontario Power Company and of the Iroquois Construction Company which has hitherto been vested in Joseph G. Robin and his associates, together with the Westinghouse Company, has passed by sale of the individual interests to a new syndicate headed by Mr. Westinghouse and John J. Albright, of Buffalo. The purchasing syndicate is understood to represent a combination of the Westinghouse, Albright, New York Central and Vanderbilt interests and those of Horace E. Andrews, of Cleveland, and others.

Mr. H. H. Westinghouse has been elected a director of the Niagara, Lockport & Ontario Power Company, succeeding Cassius M. Wicker. The officers are as follows: General Francis V. Greene, president; F. B. H. Paine, formerly export manager of the Westinghouse Electric and Manufacturing Company, vice-president and chief engineer; Robert C. Board, secretary; and Clifford Hubbell, treasurer. The offices of the company have been moved to the Fidelity Building, Buffalo. S. M. Clement, president of the Marine National Bank, of Buffalo, succeeds Mr. Robin on the board of syndicate managers for the underwriting of the company's securities.

The transmission line projected has already been built from the Niagara river three-quarters of the way to Lockport, and is being rapidly pushed toward Rochester. A long term agreement has been made by the Niagara, Lockport & Ontario Power Company to supply electrical power to the New York Central Railroad Company, and contracts have been made to supply power to local railroads and to private consumers at almost every town from Niagara Falls to Syracuse, including the latter city. By the middle of next spring it is expected the most of the electric railroads of Syracuse will be run by Niagara power transmitted by this company.

Lightning Protection Investigation.

At a recent meeting of the National Electric Light Association held in Denver, June 6, 7 and 8, one of the most interesting discussions was that provoked by the report of the committee on protection from lightning and other static disturbances. This report was presented by Messrs. Alex Dow and Robert S. Stewart. It gave a brief review of the various methods adopted to protect electrical systems from damage by lightning, and showed as far as possible the results attained. As the subject is one of extreme importance, it has been decided to continue the investigation throughout the next year, and to this end President Wm. H. Blood, Jr., has appointed a committee consisting of Messrs. Alex Dow, Robert S. Stewart, both of Detroit, and Mr. Orville A. Honnold, of Salt Lake City, to report at the next convention. All of the gentlemen have excellent opportunities for gathering information and experience, and a valuable report is expected. It is also expected that all members of the National Electric Light Association who may have any data that can be of use to the committee, that they will send it to the chairman, Mr. Dow.

Civil Service Examinations for New York State Service.

The New York state civil service commission will hold a general examination on September 9. Among the positions to be filled are the following: lecturer and instructor at Farmers' Institute; three positions at $2,500; leveler, state engineering department, $4.50 to $5 per day; tracer, state engineers and state architects' offices, $30 to $50 per month. The last day for filing applications for positions is September 4. Application forms and detail information may be obtained by addressing the chief examiner of the commission, Charles S. Fowler, Albany, N. Y.

Meeting of the British Association in South Africa.

The seventy-fifth meeting of the British Association is now being held in South Africa. Several large parties left England during the latter part of July to attend the meeting. The programme calls for meetings at which papers will be read and discussed at Cape Town on August 16, 17, 18 and at Johannesburg beginning August 28. A large number of papers are promised and a number of public lectures will be delivered. A number of towns will be visited, and a party of about 300 will visit Victoria Falls. Presidential addresses will be delivered at Cape Town and Johannesburg. One of the lectures will be by Professor W. E. Ayrton on the distribution of power. Sir William Crookes will lecture on diamonds, and Professor Porter on the bearing of engineering on mining.

The following lists give the papers to be read in Sections A (mathematics and physics) and G (engineering).

Section A (mathematics and physics). Cape Town: president's address; progress of the arc of meridian and geodetic survey of South Africa, Sir D. Gill; to what extent can the ether affect the motion of matter? Professor J. Larmor; observations of atmospheric electricity in South Africa, Professor Beattie and Mr. Lyle; leak of electricity from certain heated substances, Professor Beattie; the foundations of the kinetic theory of gases, Mr. Burbury; application of the kinetic theory of nebulæ, Mr. J. H. Jeans; radiation at low temperatures, Dr. J. T. Bottomley. There will also probably be communications from Mr. Hough on tides, and from Dr. Roberts on the Algol variables. Johannesburg: on the teaching of elementary mechanics (jointly with Section L if possible), Professor J. Perry; on flight, Professor G. H. Bryan; (1) electrical conductivity in relation to chemical action; (2) magnetic survey of South Africa, Professor Beattie; report of the seismological committee, Professor J. Milne; a form of dry Daniell cell, Mr. J. Brown; the strength of winding ropes in mines, Professor Perry; the experimental foundations of the theory of heat conduction, Dr. C. H. Lees. There will probably be a communication from Mr. Sutton on the meteorology of South Africa.

Section G (engineering)—Cape Town: Metcalfe on Zambezi bridge and Rhodesian railways; ocean turbine boats, Professor Byles; roller bearings, wire ropes in mines, and probably automobiles. Johannesburg: president's address (irrigation); strength of winding ropes in mines, Professor Perry.

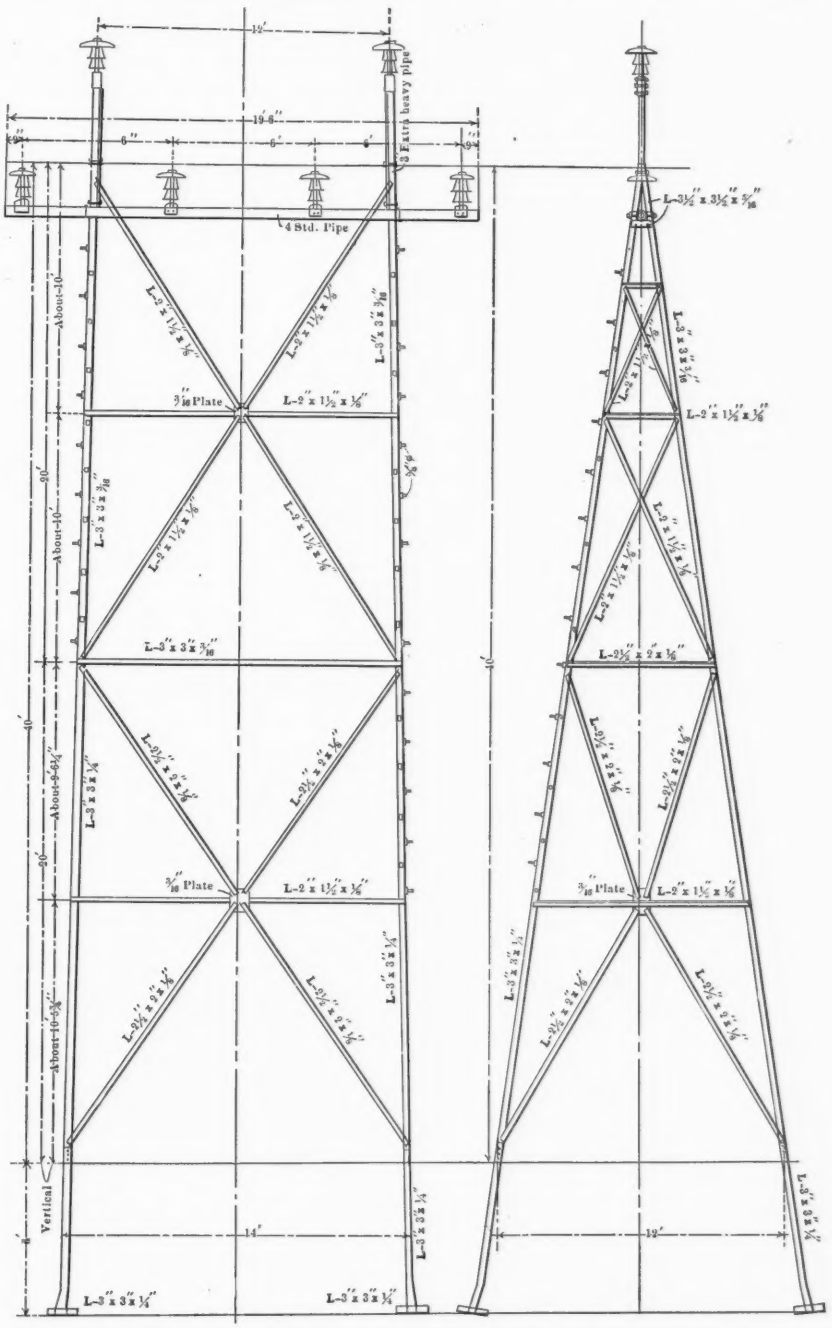
The Use of Steel Towers and Wooden Poles.

By Alton D. Adams.

STEEL towers are rapidly coming into use for the support of electric transmission lines that deliver large units of energy at high voltages to long distances from water powers.

One case of this sort is the seventy-five-mile transmission of 40,000-horse-power at 60,000 volts from Niagara Falls to Toronto, for which a line with steel towers is now nearing completion. Another example may be seen in the seventy-five-mile line of steel towers which carries transmission circuits of 60,000 volts to Winnipeg. Guanajuato, Mexico, which is said to have produced more silver than any other city in the world, receives some 3,300 electric horse-power over a 60,000-volt transmission line 100 miles long on steel towers. Between Niagara Falls and Lockport the electric circuits now being erected are supported on steel towers. On a transmission line eighty miles long in northern New York, for which plans are now being made, steel towers are to support electric conductors that carry current at 60,000 volts.

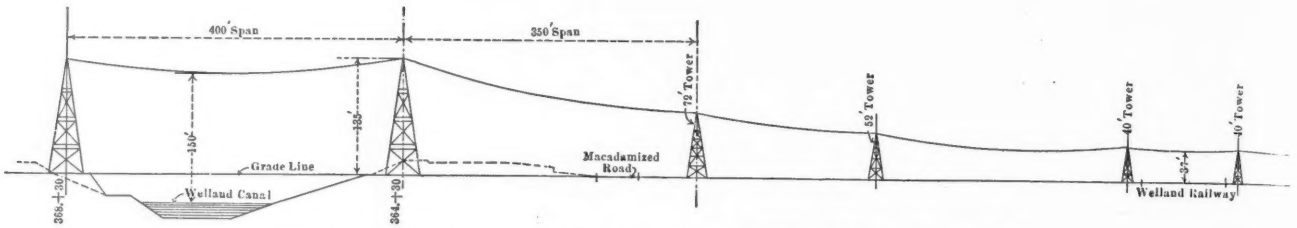
For the elevations above ground at which it is common to support the conductors of transmission lines, that is from thirty to fifty feet, a steel tower will cost from five to twenty times as much as a wooden pole in various parts of the United States and Canada. It follows at once from this fact that there must be cogent reasons, apart from the matter of first cost, if the general substitution of steel towers for wooden poles on transmission lines is to be justified on economic grounds. During fifteen years the electric transmission of energy from distant water powers to important centres of population has grown from the most humble beginnings to the delivery of hundreds of thousands of horse-power in the service of millions of people, and the lines for this work are supported with very few exceptions on wooden poles. Among the transmissions of large powers over long distances at very high voltages that have been in successful operation during at least several years with wooden pole lines are the following: the 60,000-volt circuit that transmits some 13,000 horse-power from Electra station across the state of California to San Francisco, a distance of 147 miles, is supported by wooden poles. In the same state the transmission line is 142 miles long between Colgate power-house and Oakland, at 60,000 volts and with a capacity of about 15,000 horse-power, hangs on wooden poles, save at the span nearly a mile long over the straits of Carquinez. Wood is used to carry the two 55,000-volt circuits that run sixty-five miles from the 10,000-horse-power station at Cañon Ferry on the Missouri river to Butte. Between Shawinigan Falls and Montreal, a distance of eighty-three miles, the conductors that deliver at least 6,000 horse-power are carried on wooden poles. Electrical supply in Buffalo to the amount of 30,000 horse-power depends entirely on circuits from Niagara Falls that operate at 22,000 volts and are supported on lines of wooden poles.



STEEL TOWERS FOR THE NIAGARA FALLS AND TORONTO TRANSMISSION LINE.

In the operation of these and many other high-voltage transmissions during various parts of the past decade some diffi-

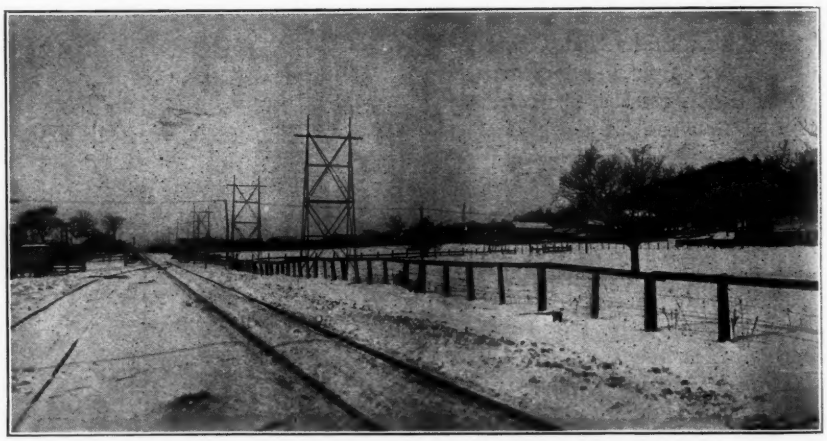
culties have been met with, but they have not been so serious as to prevent satisfactory service. Nevertheless it is now being urged that certain impediments that are met in the operation of transmission systems would be much reduced by the substitution of steel towers for wooden poles, and it is even suggested that perhaps the first cost, and probably the last cost, of a transmission line would be less with steel than with wood for supports. The argument for steel in the matter of costs is that while a tower requires a larger investment than a pole, yet the smaller number of towers as compared with that of poles may reduce the entire outlay for the former to about that for the latter. More than this, it is said that the lower depreciation and maintenance charges on steel supports will make their final cost no greater than that of wooden poles.



PROFILE OF NIAGARA FALLS AND TORONTO TRANSMISSION LINE AT WELLAND CANAL.

In the present state of the market, steel towers can be had at from three to three and one-half cents per pound, and the cost of a steel tower or pole will vary nearly as its weight. During the first half of 1904 the quotations on tubular steel poles to the Southside Suburban Railway Company, of Chicago, were between the limits just stated. That company ordered some poles built up of steel sections about that time at a trifle less than three cents per pound. Each of these poles was thirty feet long and weighed 616 pounds, so that its cost was about eighteen dollars (xxi, A. I. E. E., 754). For a forty-five-foot steel pole to carry a pair of 11,000-volt, three-phase circuits along the New York Central electric road the estimated cost was eighty dollars in the year last named (xxi, A. I. E. E., 753). On the 100-mile line to Guanajuato, Mexico, above mentioned, the steel towers were built up of 3″ x 3″ x $\frac{3}{16}$″ angles for legs, and were stayed with smaller angle sections and rods. Each of these towers has four legs that come together near the top, is forty feet high, weighs about 1,500 pounds, and carries a single circuit composed of three No. 1 B. & S. gauge hard-drawn copper cables. The weight of each of these cables is 1,340 pounds per mile, and the forty-foot towers are spaced 440 feet apart, or twelve per mile, over nearly the entire length of line. At three cents per pound, the lowest figure at which these towers could probably be secured for use in the United States, the approximate cost of each would be forty-five dollars. Between Niagara Falls and Lockport each of the steel towers that is to carry a single three-phase transmission circuit has three legs built up of tubing that tapers from two and one-half inches to smaller sizes, and is braced at frequent intervals. The height of these towers is forty-nine feet, and the weight of each is 2,800 pounds. At three cents per pound the cost of each tower amounts to eighty-four dollars. For a long transmission line in northern New York bids were recently had on towers forty-five feet high to carry six wires, and the resulting prices were $100 to $125 each for a tower weighing about 3,000 pounds. On the seventy-five-mile line between Niagara Falls and Toronto the standard height of steel towers is forty feet from the ground level to the point where the two legs of each side join, and to this must be added a length of six feet that goes into the ground, and about three feet of pipe that run up from the junction of each pair of legs at the top, giving a total length of forty-nine feet exclusive of insulator pins. Except as to a cross-arm of standard four-inch steel pipe, and the two uprights of extra heavy three-inch pipe at the top, this tower is built up almost entirely of L sections that vary from 3″ x 3″ x $\frac{1}{4}$″ to 2″ x 1$\frac{1}{2}$″ x $\frac{1}{8}$″. The weight of this tower is very close to 2,360 pounds, and its cost at three cents per pound would amount to about seventy dollars. On the line of these towers there are strung six hard-drawn copper cables with a cross-section of 190,000 circular mils each. Between these standard towers the maximum spacing is 400 feet, but this length of span is much reduced on curves and where the ground is uneven, so that about 1,400 towers are used on the seventy-five-mile line, which gives an average spacing of 283 feet.

In January, 1902, four steel towers were purchased to support transmission circuits for two spans of 132 feet each over the Chambly canal, near Chambly Canton, Quebec. Each pair of these towers was required to support eleven No. 2/0 B. & S. gauge bare copper wires with the span of 132 feet between them. The vertical height of each of these four towers is 144 feet above the foundation, and they were designed for a maximum stress in any member of not more than one-fourth of its ultimate strength, with wires coated to a diameter of one inch with ice and under wind pressure. For these four steel towers erected on foundations supplied by the

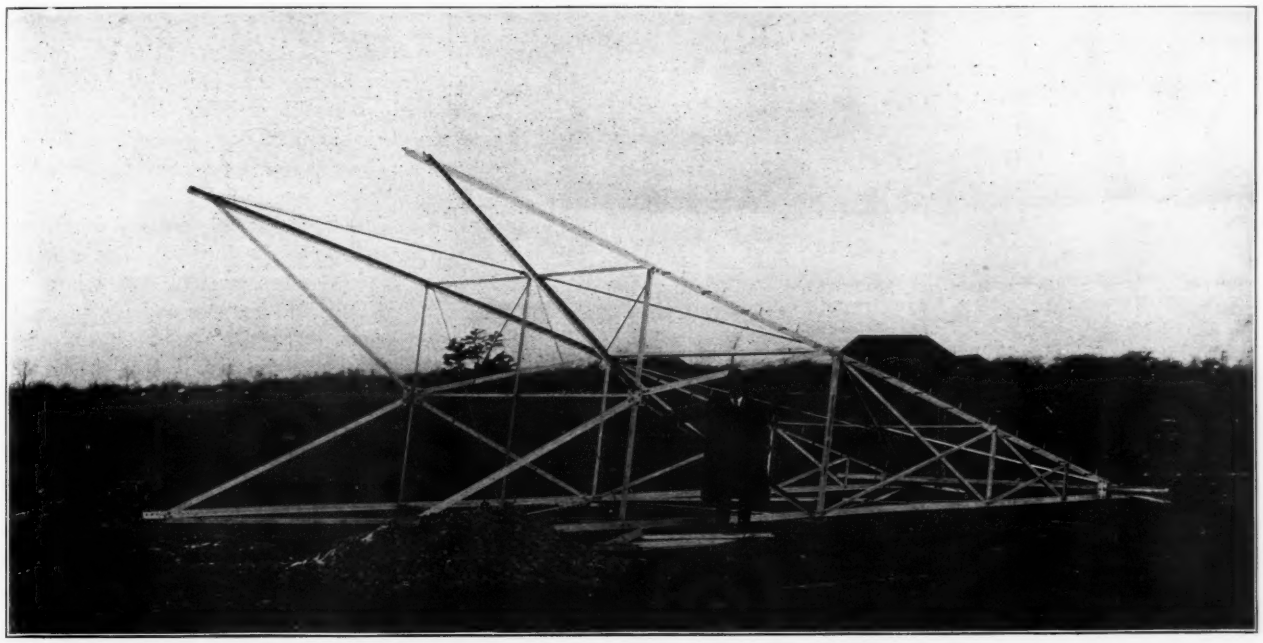


NIAGARA FALLS AND TORONTO TRANSMISSION LINE.

purchasers the price was $4,670, and the contract called for a weight in the four towers of not less than 121,000 pounds. On the basis of this weight the cost of the towers erected on foundations was 3.86 cents per pound.

With these examples of the cost of steel towers a fair idea may be got of the relative cost of wooden poles. For poles of cedar or other desirable wood thirty-five feet long and with eight-inch tops fitted with either one or two cross-arms an estimated cost of five dollars each is ample to cover delivery at railway points over a great part of the United States and Canada. This size of pole has been much used on the long, high-voltage transmission systems that involve large power units and use heavy conductors. Examples of lines where such poles are used may be seen between Niagara Falls and Buffalo, between Colgate power-house and Oakland, and between Cañon Ferry and Butte. Of course some longer poles were used in special locations, like the crossing of steam railways, but it is also true that on the lines supported by steel towers such locations make exceptionally high towers necessary. The thirty-five-foot poles will hold the electric lines about as high above the ground level as the forty-nine-foot towers on the Niagara Falls and Toronto transmission, because the former will be set so much closer together. On the line just named the regular minimum distance of the electric cables above the ground level at the centres of spans is twenty-five feet. The standard towers on this line carry the lower electric cables forty feet above the ground at the insulators, and it was thought desirable to allow a sag of fifteen feet at the centres of the regular spans of 400 feet each. On these towers the conductors that form each three-phase circuit are six feet apart, and the lines drawn between the three cables form the sides of an equilateral triangle. With a pin fourteen and three-fourths inches long like that used on these steel towers, and one conductor at the top of a thirty-five-foot pole, where the other two are supported by a cross-arm five feet three inches below, giving six feet between cables, the lower cables are held by their insulators twenty-six feet above the ground, when the poles are set five feet deep. Between thirty-five-foot poles 100 feet is a very moderate span, and one that is exceeded in a number of instances. Thus on the 142-mile line from Colgate power-house to Oakland the thirty-five-foot poles are 132 feet apart, and one line of these poles carries three conductors of 133,000-circular-mil copper, while the other pole line has three aluminum cables of 168,000 circular mils. On the later transmission line from Niagara Falls to Buffalo, which has one three-phase circuit of 500,000-circular-mil cable, the regular distance between the thirty-five-foot poles is 140 feet.

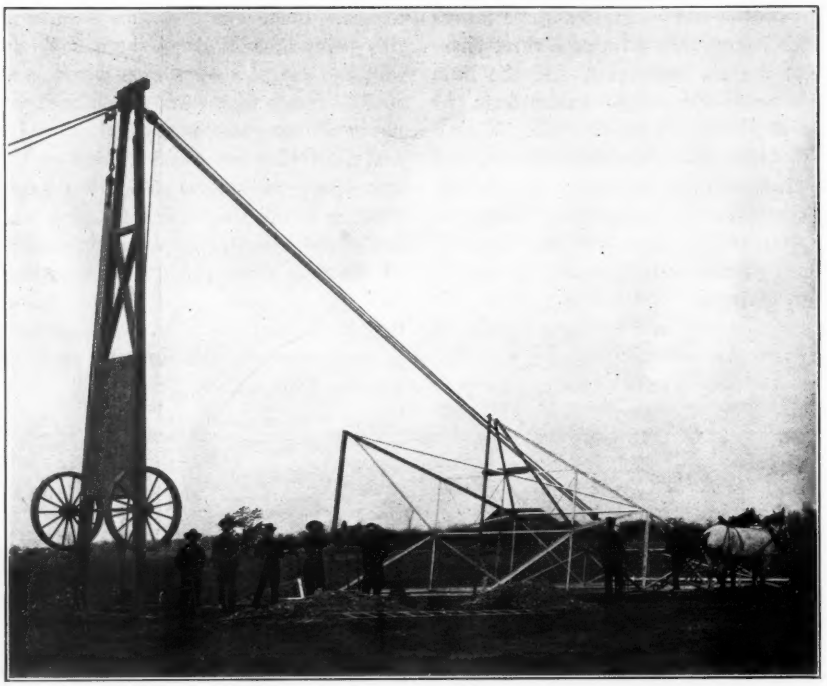
A maximum sag of twenty-four inches between poles 100 feet apart under the conditions named above brings the lowest points of the electric cables twenty-four feet above the ground. The steel towers on the line to Guanajuato being only forty feet in length, and spaced 440 feet apart, it seems that the distance of conductors from the ground at the centres of spans is probably less than that just named. Particular attention is called to this point because it has been suggested that the use of steel towers would carry cables so high that wires and sticks could not be thrown onto them. It thus appears that thirty-five-foot wooden poles set 100 feet apart will allow as much distance between conductors, and still keep their lowest points as far above the ground, as will forty to forty-nine-foot towers placed 400 feet or more apart. The two lines that have their conductors further apart perhaps than any others in the world are the one from Cañon Ferry to Butte, on thirty-five-foot wooden poles, and the one to Guanajuato, on steel towers. In each of these cases the cables are seventy-eight inches apart at the corners of an equilateral triangle. With steel towers 400 feet or wooden poles 100 feet apart, four of the latter must be used to one of the former. At $5 per pole this requires an investment of $20 in poles as compared with at least $45 for a tower like those on the Guanajuato line, $84 for a tower like those on the line from Niagara Falls to Lockport, or $60 for one of the towers on the Niagara and Toronto line. Each of the towers on the line to Toronto carries two three-phase circuits, and the least distance between cables is six feet. To reach the same result as the distance between conductors with the two circuits on poles, it would be desirable to have two



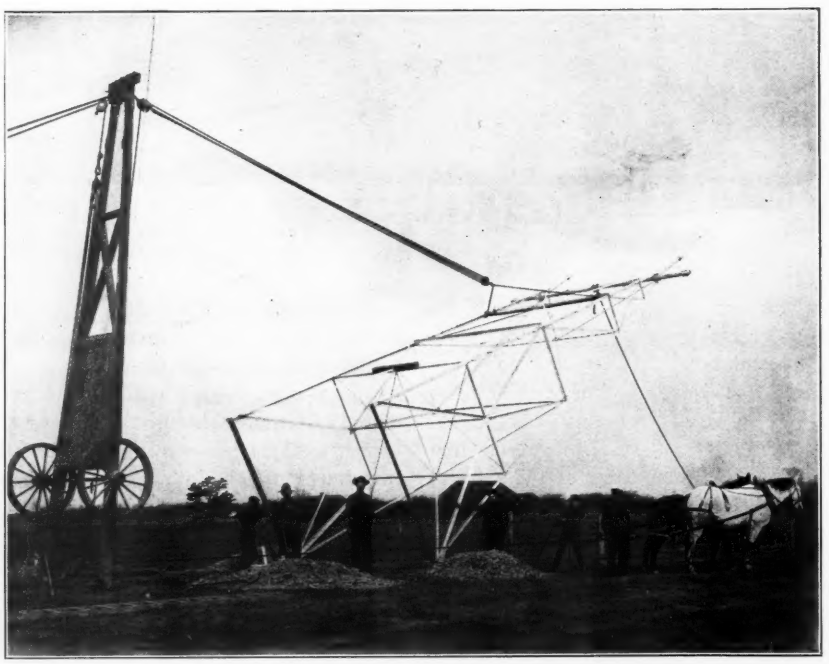
Steel Tower on Niagara Falls and Toronto Transmission Line.

pole lines, so that $40 would represent the investment in the poles to displace one tower for two circuits. The older pole line between Niagara Falls and Buffalo carries two three-phase circuits on two cross-arms, and the 350,000-circular-mil copper cables of each circuit are at the angles of an equilateral triangle whose sides are each three feet long. In this case, however, the electric pressure is only 22,000 volts.

The costs above named for poles and towers include nothing for erection. Each tower has at least three legs and more commonly four, and owing to the heights of towers and to the long spans they support, it is the usual practice to give each leg a footing of cement concrete. It thus seems that the number of holes to be dug for a line of towers is nearly or quite as great as that for a line of poles, and considering the concrete footings the cost of erecting the towers is probably greater than that for the poles. With wooden poles about four times as many pins and insulators are required as with steel towers, or say twelve pins and insulators on poles instead of three on a tower. For circuits of 50,000 to 60,000 volts the approximate cost of each insulator with a steel pin may be taken at $1.50, so that the saving per tower reaches not more than $13.50 in this respect. In the labor of erecting circuits there may be a small advantage in favor of the towers, but the weight of the long spans probably offsets to a large extent any gain of time due to fewer points of support.



READY TO RAISE A TOWER WITH THE DERRICK WAGON, NIAGARA FALLS AND TORONTO TRANSMISSION LINE.

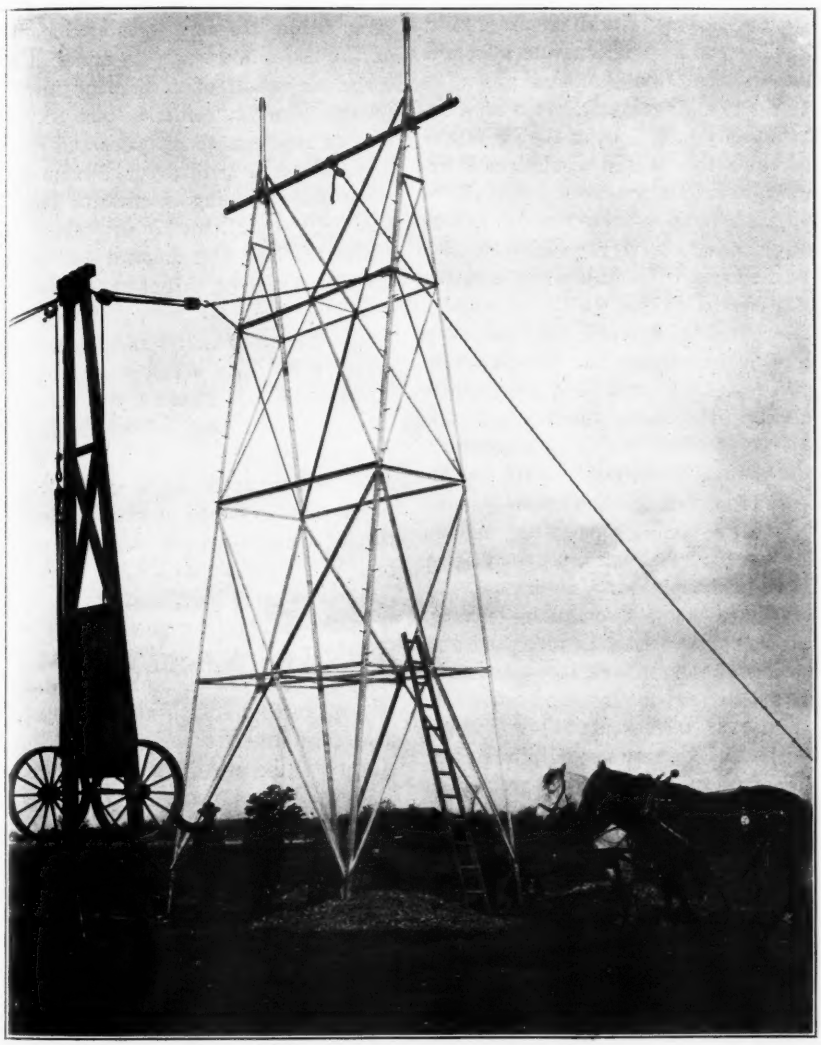


RAISING A TOWER WITH DERRICK WAGON, NIAGARA FALLS AND TORONTO TRANSMISSION LINE.

An approximate conclusion from the above facts seems to be that a line of steel towers will probably cost from 1.5 to twice as much as a line or lines of wooden poles to support the same number of conductors the same distance apart, even when the saving of pins and insulators is credited to the towers. This conclusion applies to construction over a large part of the United States and Canada. It is known that wooden poles of good quality retain enough strength to make them reliable as supports during ten or fifteen years, and it is doubtful whether steel towers will show enough longer life to more than offset their greater first cost. It may be noted here that any saving in the cost of insulators or other advantage that there may be in spans 400 feet or more long can be as readily secured with wooden as with steel supports. With these long spans the requirements are greater height and strength in the line supports, and these can readily be obtained in structures, each of which is formed of three or four poles with cross-braces. Such wooden structures have long been in use at certain points on transmission lines where special long spans were necessary, or where there were large angular changes of direction. In those special cases where structures 75 to 150 or more feet in height are necessary to carry a span across a waterway, as at the Chambly canal above mentioned, steel is generally more desirable than wood because poles of such lengths are not readily obtainable. Neither present proposals nor practice, however, contemplates the use of steel towers having a length of more than forty to fifty feet on regular spans.

Much the strongest argument in favor of steel towers for transmission lines is

that these towers give a greater reliability of operation than do wooden poles. It is said that towers will act as lightning-rods and thus protect line conductors and station apparatus. As to static and inductive influences from lightning it is evident that steel towers can give no protection. If each tower has an especial ground connection it will probably protect the line to some extent against direct lightning strokes, but there is no reason to think that this protection will be any greater than that given by well grounded guard wires, or even by a wire run from a ground plate to the top of each pole or wooden tower. If a direct lightning stroke passes from the line conductors to a wooden support it frequently breaks the insulator on that support, and the pole is often shattered or burned. Such a result does not necessarily interrupt the transmission service, however, as the near-by poles can easily carry the additional strain of the line until a new pole can be set. Quite a different result might be reached if lightning or some other cause broke an insulator on a steel tower, and thus allowed one of the electric cables to come into contact with the metal structure, as the conductor would then probably be burned in two. To repair a heavy cable thus severed where the spans were as much as 400 feet long would certainly require some little time. Where a conductor in circuits operating at 20,000 to 35,000 volts has in many cases dropped onto a wooden cross-arm, it has often remained there without damage until discovered by the line inspector, but no such result could be expected with steel towers and cross-arms (xxi, A. I. E. E., 760). Where steel towers are employed it would seem to be safer to use wooden cross-arms, for the reasons just stated. This is, in fact, the practice on the steel towers before named, that support 25,000-volt circuits over the Chambly canal, and also on the steel towers that carry the 60,000-volt circuits from Colgate power-house over the mile-wide straits of Carquinez.



TOWER JUST UP, NIAGARA FALLS AND TORONTO TRANSMISSION LINE.

On the 40,000-volt transmission line between Gromo and Nembro, Italy, where timber is scarce and steel is cheap, both the poles and cross-arms are of wood. It is thought that the comparatively small number of insulators used where a line is supported at points about 400 feet apart should contribute to reliability in operation, but insulators now give less trouble than any other part of the line, and the leakage of energy over their surfaces is very small in amount, as was shown in the Teluride tests. Whatever benefits are to be had from long spans are as available with wooden as with steel supports, and at less cost.

One advantage of steel towers over wooden poles or structures is that the former will not burn, and are probably not subject to destruction by lightning. Where a long line passes over a territory where there is much brush or timber the fact that steel towers will not burn may make their choice desirable. In tropical countries where insects rapidly destroy wooden poles the use of steel towers might be highly desirable even at much greater cost, and such a case was perhaps presented on the line to Guanajuato, Mexico.

Mechanical failures of wooden insulator pins have been far more common than those of poles, both as a direct result of the line strains, and because such pins are often charred and weakened by the leakage of energy from the conductors. For these reasons the general use of iron or steel pins for the insulators of long lines operating at high voltages seems desirable. Such pins are now used to support the insulators on a number of lines with wooden poles and cross-arms, among which may be mentioned the forty-mile, 30,000-volt transmission between Spier Falls and Albany, and the forty-five-mile 28,000-volt line from Bear river to Ogden, Utah. Iron or steel pins add very little to the cost of a line, and materially increase its reliability. One of the cheapest and best forms of steel pins is that swaged from a steel pipe, and having a straight shank and tapering stem with no shoulder. A pin of this sort for the 400-foot spans of 190,000-circular-mil copper cable on the line from Niagara Falls to Toronto measures three and one-quarter inches long in the shank, eleven and one-half inches in the taper, and has diameters of two and three-eighths inches at the larger and one and one-eighth inches at the smaller end.

On long transmission lines where the amount of power involved is very large, the additional reliability to be had with steel towers is probably great enough to justify their use. For the great majority of power transmissions, however, it seems probable that wooden poles or structures will long continue to be much the cheaper and more practicable form of support.

APPLICATION OF ELECTRICITY TO MINES.[1]

BY A. C. ANDERSON.

CHOICE OF A SYSTEM.

The mine owner or manager who wishes to install electrical plant is immediately confronted with the question as to system. He wants the utmost efficiency and reliability, and these with a low capital expenditure and small maintenance costs. Opinion on this point is very divergent. Three-phase, though costly to produce, owing to the relatively poor power-factor, is the cheapest to install, given material and workmanship of equal quality.

From the results of experience it seems to have the greatest freedom from breakdown, with consequently reduced maintenance costs; moreover, it is very efficient in the generation, distribution, and transformation of energy in the main, but it is much hampered by line losses at low load and fall of pressure due to starting of motors. It is urged that by the use of induction motors sparking is entirely obviated, a point of paramount importance in fiery mines. Certainly the possible sparking at the commutator of the direct-current motor is got rid of, but there always remains the chance of a break in the mains or failure of the windings.

Moreover, the direct-current machine may be made gastight, and though sparking in such motors when driving coal-cutters may not be absolutely eliminated because of the excessive vibration, it is thereby rendered harmless. For haulage plants, motor-generators or converters are necessary with an alternating system, and batteries in the main are out of the question. The small air-gaps in polyphase motors necessary for a good power-factor necessitate the closest and most frequent inspection to prevent trouble. They are hardly suited for the drastic conditions of coal-cutting. Coal-cutters are also very disadvantageous to three-phase motors owing to the constantly varying load and consequent fluctuation in line pressure. This is sometimes so serious as to make it necessary to have separate plants for power and lighting. Such complication as this entails is very prejudicial to the employment of alternating currents. The excessive starting current taken by induction motors can only be made light of when the generating plant, etc., is relatively very large. With a well-designed squirrel-cage rotor a fair torque is obtained at starting, but the rush of the current is far greater than for a direct-current motor giving the same starting effect. A heavy line drop is thus inevitable unless a special expenditure is made in cables. Resistances can not be done away with in connection with induction motors, but in place of a separate box they may be arranged in the rotor itself, or some pole-changing device may be adopted. This, however, will probably mean additional slip rings and contacts. It would appear that fuses rarely blow on overloading of three-phase motors, as the windings exert a choking-coil effect, which keeps the current within certain limits. Variable speed with alternating motors is a most difficult problem, and proscribes their use to a large extent. It is an absolute necessity with fans, as the air supply must be capable of nice regulation. Moreover, one is rather restricted in the choice of speeds with three-phase motors. Alternating motors are very good when they can be run on constant load at constant speed, conditions met with in certain classes of pumping work, etc. By-passes can easily be arranged on the pumps to allow of gradual starting. A single-phase system, if it could be made practicable, would be most suitable for mining work. Three-phase alternating is quite unsuitable for locomotive traction in mines where trolley wires would be permitted and no other form of alternating current is at present admissible for general use. It would be reasonable in some cases to transform from alternating to direct current by means of rotaries or motor-generators, more especially if the frequency of supply was fifty, or thereabouts. For a large scheme such as where several pits are fed from one central station above ground, an alternating system would unquestionably be adopted, at any rate for transmission. Continuous current is eminently suitable for large machines, such as winding and haulage gears, and large pumps, owing to great comparative ease of starting and regulating.

Speed variation is practically essential in most of the departments of mining work, and can now be accomplished very economically with direct-current machinery. In addition, a continuous-current system gives far better results on varying load (also an essential of mining work) than an alternating one. It seems to me that rather too much stress has been laid on commutator sparking. Arcing in switches is unavoidable in any case. It has been said that the direct-current motor can not be entirely enclosed, a fact cited as showing a distinct advantage of the induction motor. There is no reason whatever why a continuous-current motor should not be completely enclosed if it is properly rated. For coal-cutting there is no motor giving a more efficient starting torque than the direct-current series type. When fuses blow with overloads on continuous-current motors driving coal-cutters, the men in charge, disliking the frequent stoppages, apparently have a knack of substituting larger and larger fuses, resulting finally in a burn-out of the armature, causing a serious waste of time. Unfortunately this sort of thing is very difficult to put down. In the evidence given before the departmental committee on the use of electricity in mines, it was stated on behalf of a company insuring electric plant at collieries that 85.7 per cent of accidents to dynamos and motors occurred in armatures or commutators, these mishaps being chiefly due to overloading. Mr. H. M. Hobart says that a continuous-current motor for coal-cutting would for a given output and speed have a smaller diameter, a much deeper air gap, a higher efficiency, and a lower temperature rise than a polyphase motor for the same work. Further, the regulation would be much more suitable for lighting circuits.

The electromotive force of an alternating system is much more flexible than that of a direct-current one; it is so easy to step up or down with static transformers, but it must be remembered that the frequency suitable for power is not suitable for lighting, a very important consideration and one which by the introduction of further complication is likely to neutralize largely the copper economy incidental to the use of alternating currents. A direct-current plant for 500 volts, in the case of comparatively small plants, on the concentric system with earthed return is very good and elastic for all classes of work, but the choice of a system must really rest on the special circumstances of the particular case.

VOLTAGE, ETC.

In the evidence rendered before the mining commission the majority of witnesses were agreed on limiting the pressure to from 500 to 600 volts at the actual workings. This seems really too cautious when compared with continental practice. To quote one instance among many, at the Gneisenau Colliery an asynchronous motor receiving current at 2,200 volts is driving a pump situated 1,476 feet below the surface. The advantages of high-tension transmission in connection with mining are doubtful unless there is a large area to be supplied from one central station, necessitating considerable lengths

[1] Abstract of paper read before the Birmingham section of the British Institution of Electrical Engineers.

of line on the surface. The new rules merely allow 650 volts as a maximum for motors or transformers up to seventy-five-horse-power capacity. Consequently, when considering the question of single collieries with closely situated shafts, a 2,000-volt system, say with its inevitable complication and increased first cost, owing to necessity for special insulation and transforming devices, is distinctly inadvisable, as not only will the economy in copper be swamped by the disadvantages named, but also a small proportion of the whole system will be worked at the high pressure. With a large and widely distributed scheme, however, a three-phase high-tension system of transmission is admirable and absolutely necessary for the best commercial results; the considerable gain in copper much more than compensates for the extra apparatus necessary. With regard to the danger objections, it has been argued that the knowledge of the use of a high pressure tends to make men more careful. This would seem to be a somewhat neutral advantage. In alternating practice a low frequency of about twenty-five should be adopted for power circuits, and for lighting certainly not less than forty-five or fifty.

GENERATING PLANT.

In the ordinary way special consideration of this portion of the installation is hardly necessary, as it is nearly always placed on the surface and is of the same nature as that in any other power station. But large size generators for mining work will most generally be required of the low-speed type, as colliery engineers much prefer to use horizontal engines for driving, as being machinery with which they are more familiar. High-speed engines of the type now almost universal in our central stations are, of course, perfectly suitable for mines, but it is somewhat difficult to persuade mining engineers to use them owing to the necessity of having a special staff of mechanics to look after them properly. Dynamos of over 250-kilowatt capacity would probably be coupled direct to the prime movers, machines of a less output being rope-driven. Without question, all generators should be liberally rated. Machines intended for use below ground, including rotary transformers or motor-generators, have specially to be designed for ease of transport. They should be as absolutely reliable as possible, both electrically and mechanically, and should be subjected constantly to the most thorough supervision. The new rules have specially provided for the proper installation and care of the generating plant. It is to be isolated, an ample sufficiency of room is stipulated for each set, and all machines at a pressure higher than 250 volts are to have their frames efficiently connected with earth. It is to be hoped that there will be no longer any of that cramped huddling together of machinery, which, unfortunately, so often characterizes mining installations.

DISTRIBUTION.

The distribution system, comprising wiring and switch-gear, is from every point of view by far the most important factor in an electrical mining installation. The few isolated cases in which mining managers have actually condemned electricity as unsuitable have been almost entirely created by shoddy workmanship and thoughtless design in the wiring scheme. It is absolutely essential for the successful adaptation of electricity to mining that the system of wiring, with its controlling gear, should be as "solidly" installed as possible with the greatest care and the best material, due regard being paid in the design to any special circumstances. For continuous-current work concentric cables with the outer conductor earthed have proved very satisfactory, but the new British rules prohibit earth circuits in the main, and the neutral point of a polyphase system may not be earthed until the district inspector of mines has been formally notified. All metallic sheathings and armoring should unquestionably be properly connected with earth. In an alternating system care must be exercised in the use of metallic armorings or the laying of cables in iron pipes to minimize, as far as possible, inductive effects. Three-core cables should be used, not triple concentric, and the algebraic sum of the currents must equal zero, as otherwise the inductive effects of the three cores will be unequal and there will be a loss in efficiency. Moreover, in special cases where for some reason direct-current and alternating mains have been laid in the same pit, great care must be taken to avoid the mutual effects of self-induction.

The most favorable means of laying cables varies largely with circumstances.

Bitumen-filled troughs are very good, but can very rarely be used in mining work without an additional armoring of the cables. Insulation, consisting of paper or jute sheathed with vulcanized fibre or vulcanized bitumen with a double armoring of galvanized steel wires, is very good for difficult situations. Opinions, however, vary widely as to the protective covering to be adopted. Trailing cables for use with coal-cutters and portable drills present a very difficult problem. It is a hard matter to combine proper flexibility with sufficiently strong and reliable armoring. Some engineers use oak or teak casing in taking the mains down the shaft, others clamp with massive wooden cleats, and in the case of a brick-lined shaft, Lewis bolts may be used to sustain the clamps. On the other hand, loose suspensions are often preferred as giving the cable a better chance of withstanding mechanical shock. Joints in the cable are best made in connection boxes, which may, of course, at the same time contain switches or fuses. It is a moot point as to whether roof suspension is better than an arrangement on the sides or in the floor. It really depends on the relative strength and general suitability of these three alternatives. Certain it is that unless proper means are taken to prevent it, a fall of roof will probably break the cable suspended therefrom—a very dangerous possibility in a "gassy" mine. With a roof suspension some arrangement should be made such as that adopted at the Hulton collieries, Bolton, where the cables are loosely suspended from the roof by means of spun yarn, so that in the event of a fall no undue tension is put on another part. The floor would seem at first sight to be the best place for the mains, but it is frequently very uneven. It should not be possible for any circuit to be opened in the presence of an inflammable gas; that is to say, all boxes enclosing switches and fuses to be used in the dangerous sections of a mine should be gastight. Further, the switches are better immersed in oil. With regard to the general control of the scheme, it is best to arrange a disconnection box to ground cables at the top of the shaft and a distribution board with switches and fuses immediately at the bottom. Switchboards of the skeleton type, where there is really no "board" at all, are excellent for straightforward work, as every detail can be so readily inspected. Mr. Roslyn Holiday, of the Ackton Hall Colliery, makes his own switch-boxes for attaching to coal-cutter motors. They are fitted with an accurately machined cover and a cement joint. The switch handle works into a box through a gland. The voltage is 320, and there has been no sparking trouble. The more complex forms of gear, especially motor-starting rheostats, should be designed for the utmost reliability and ease of working. The movement of the switch arm over the contacts should be restrained in order to reduce the risk of an armature burn-out, an accident which

should be rendered still more improbable by the use of proper protective devices in circuit with the machine. All metallic boxes, etc., should be earthed.

MOTORS.

When enquiring for motors for use in mines, managers should invariably specify as clearly as possible the exact nature of the load, the maximum temperature rise permissible, and any peculiar conditions under which the machine may have to work. The question of temperature is a difficult one owing to the very different conditions prevailing in different parts of the same mine; but the engineer should know where his motors are going, and can specify accordingly. Of course, in the case of portable gear, which may be used anywhere, the worst possible case must be provided for, and an adequate factor of safety allowed. As far as possible, motors for use underground should be enclosed in motor rooms. This is manifestly impossible in the case of coal-cutters, drills, and locomotives, where, at any rate, in dangerous mines (locomotives being eliminated), the case of the motor should be its own room, so to speak. With regard to continuous-current gastight motors, it is held that inspection covers must be provided, and that this is like giving the miner an unlocked safety lamp. Why not give the miner a locked motor, and make its inspection a part of the general system? Mr. Henry Hall thinks that a motor can not be kept properly cool if it is totally enclosed; this is obviously wrong.

It is merely a question of rating. The induction motor has a slight pull here, as, though the modern continuous-current motor is practically sparkless, the frequently intense vibration in coal-cutting and drilling must eventually cause some trouble with the latter type. Totally enclosed motors for certain conditions are absolutely necessary, and unfortunately there seems some foundation for the assertion that anything quite enclosed is liable to neglect. They should be most carefully designed not to overheat and should be rated carefully in accordance with the nature of the load, a special margin being allowed for coal-cutters and drills, which meet with the roughest treatment. The machine is not always switched off at once when the cutter jambs. All motors should certainly be guarded from circumstances such as these by means of suitable cut-outs, preferably situated in a properly protected box, obviating serious burn-outs in the windings, which have proved so far a very frequent source of accident. Armature belts are best away in motors for stringent conditions, the conductors being held in their slots by wedges. The shunt "kick" of machines should always be taken up in the controlling gear to prevent the possibility of sparking at contacts.

Mr. Garforth, of Normanton, who has made some very interesting experiments on the risks of explosion with motors, found that gas can get through an armature shaft bearing, but not in sufficient quantity to cause an explosion internally. He also found that the internal explosion incidental to the admission of gas to the interior of a gastight case did not fire the gas outside the case. Mr. W. C. Mountain performed some experiments with motors at the request of the committee dealing with the use of electricity in mines. He got no explosion with a mixture of gas and air when the proportion of the former to the latter was as 1 is to 15.

He was further able to increase this to 1 to 10, and even to 1 to 8, without the occurrence of any explosion. When he adjusted the brushes, with the set purpose of making the machine spark, an explosion took place when the proportion of gas to air was 1 to 10.

PUMPING.

Electricity is most commonly applied in mines to pumping, a use to which it is eminently suited, especially in connection with centrifugal pumps at constant load. In the Montreal pits of the Rochela-Moliers and Firminy Mining Company, the workings being gassy, the motor (three-phase) has a closed circuit winding without slip rings, and no switches are placed underground. To start the plant the generator, an inductor alternator, is fully excited, and then run up slowly, taking the pump gradually to full speed with it. Near Dortmund there are some 655 horse-power pumping sets taking current at 2,500 volts, where two methods of starting up are provided. The motor may be connected to one of the two dynamos which is at rest and attain full speed with it. This is the simplest way. No collector rings are required on the motor, but it is first necessary to stop a dynamo. Two separate three-phase circuits must be allowed for at the switchboard—one for ordinary light and power, and one for pump motors. It was found desirable to be able to start the motor direct, and an oil-cooled starting box was put in, by which means resistance was introduced into the rotor circuit.

At Horcajo, in connection with electrically driven pumps, Heerwagen's short-circuited rotor answers very well. The stator bears nine coils, each of forty-two turns; the three coils of each phase are in series, but the three phases are connected in mesh fashion. The rotor carries 360 flat copper rods arranged in two layers, in 180 holes, and is so connected that six rods are in series, thus giving sixty circuits. The centrifugal pumps can start with zero torque, gradually increasing, and can be brought to full speed when full of water in 100 seconds. The motors are started by means of an autotransformer giving 400 volts, the primary pressure being 1,000 volts. When the autotransformer is switched in the first motor is joined to the starting bars, and takes at first from 200 to 240 amperes, but rapidly reaches synchronism. This point is marked by a sudden decrease in current strength, when the connections are changed over to main bus-bars; so that motor continues to run at full pressure. The second motor is then started in the same way, and the autostarter finally cut out.

WINDING AND HAULAGE.

Electricity has not as yet come much into vogue for winding in this country, though electrically driven haulage gears have made much headway. Of the many ingenious devices designed to meet the difficult conditions of a winding plant, the Ilgner Siemens & Halske is the best known. Here a multiphase current drives a motor direct coupled to the armature of a continuous-current dynamo, the connecting shaft carrying a heavy flywheel. The direct current from the dynamo drives the motor coupled direct to the winding drum. The energy thus stored in the flywheel is available for starting the cage. Speed variation is possible by varying the field strength of the dynamos (which should be separately excited) driving the winding motor. Under ordinary working conditions an efficiency of sixty per cent may be looked for. This figure represents the ratio of the power available for raising the load in the shaft to that at the terminals of the motor-generator. For winding where electric driving has superseded steam, the cost of working has been much reduced, the steam consumption per horse-power-hour coming down to twenty-four pounds to twenty-six pounds on mineral raised. The constant turning moment of the electrical motor is more favorable to the life of ropes than the varying torque of steam engines. "Dancing of the rope" is done away with, and drums can be much lighter than with steam-winding plant. The Koepe pulley

system is specially suitable for electricity owing to the high speed. In an interesting paper on "Some Applications of Electricity in German Mines," the vital point of this system is described as follows: "the Koepe pulley consists of a grooved pulley of large diameter mounted on a shaft coupled to the winding motor. The winding rope passes round this pulley and over the pit-head gear outside the winding shed, and is thence attached to the cages. It forms thus an endless system. The arc of contact of the rope on the Koepe pulley is so chosen that the maximum loads occurring are lifted by the friction alone between the rope and the pulley, an ample safety factor being allowed for. It has been found possible, working this system electrically, to reduce the weight of the winding pulley to about one-half the weight of the drums usually required for steam-winding plant."

It is best to use liquid rheostats in connection with haulage gears. Batteries are very good for leveling load on winding machinery. The braking of haulage plants is frequently accomplished by making the motors run as generators returning current to the line, but this is always backed up by hand and automatic devices. There was exhibited at Dusseldorf a winding engine where the varying load was taken up by a storage battery, and to this an Ilgner drive has now been added. About 1,000 tons are raised per day. The Ilgner drive consists of a 300-horse-power motor on a 500-volt direct-current circuit driving a steel flywheel four millimetres diameter, weight about forty tons, and a direct-current dynamo at speeds up to 350 revolutions per minute. The motor, flywheel, and dynamo are all arranged on the same shaft. The dynamo sends current up to 2,000 amperes into winding motors, whose terminal voltage increases to 500 volts. The balancing of power is effected by the variation in speed of the flywheel shaft. The plant at the Thiederhall pit, installed by Siemens & Halske, is driven by two continuous-current motors with an equalizing battery for starting and speed regulation.

COAL-CUTTERS.

(*c*) Coal-cutters should be lavishly designed for strength and reliability in working. They should be able to stand at least thirty per cent overload for short periods, and they must be reversible. It is held by some that an arrangement of two motors in series is good for coal-cutter driving, as each machine has only half the line voltage across its terminals, and not only is the weight better distributed, but there is generally more head room. The starting switch should be enclosed in an airtight case. Provision must be made for carrying seventy yards or so of armored cable on the motor-truck, preferably coiled on a drum. The box containing the main switch and fuses should be placed where work is commenced, and cable should be paid out as the cutter advances, a sufficient length having been provided for the face of coal to be cut during a given shift. In the case of disc machines, for satisfactory working there should be a good floor and roof, and the material in which the cutter works should not be too hard, and as free from ironstone balls as possible.

DRILLING.

With regard to rock drills, where electricity is in keen competition with compressed air, it is to be noted that:

(1) With pneumatic drills there is the deafening noise of the exhaust, no power to draw back the drill when jammed in the bore hole, and there are heavy losses in cumbersome piping. Moreover, a severe capital outlay is unavoidable owing to the large power and space required, and the plant when installed is very inefficient.

(2) Electric drills are much lighter and more handy than the above, occupying but little room. They are thirty per cent cheaper in first cost than air drills, and the medium for transmission of energy is far more flexible and efficient. The Durkee electric drill is driven through a flexible shaft by an independent motor of one and one-half horse-power. The motion is given by a special crank, which gives a slow return and a quick forward or cutter stroke; the driving collar moves the drill spindle through springs so as to cushion the motor of the drill if the cutter is not striking the rock and to allow for irregularities in the feed. The drill is rotated by the usual rifled rod and pawl. The machine weighs 230 pounds without tripod and makes 580 strokes per minute.

The Marvin percussion drill of solenoid type, requiring a special alternator, needs from twenty to thirty-two kilowatts at generator, and delivers 450 to 550 blows per minute. Drills of the Marvin and Van der Pode type, however, have never been a commercial success, as they get hot and require, besides a special generator, cooling arrangements, rendering them liable to get out of order. Mr. Walsh, in the *Engineering and Mining Journal*, of New York, discusses electric drills working in the mines of the Consolidated Cariboo Hydraulic Company, at Bullian, British Columbia; direct-current portable one and one-half-horse-power and two-horse-power motors are used. Three drills averaged 312 feet of holes in ten hours through solid rock. The total cost of running the drills for ten hours was about 131 shillings, saving approximately $52 on hand drilling. The power was generated by steam engines, so that the results can not indicate the maximum efficiency obtainable. The consumption of power was considered without reference to wages. The tests were extensive enough to give good average values. An eighty-six-inch hole, two inches in diameter, was drilled in 19.08 minutes. Total consumption of power was 940 watt-hours, or 131 per foot. Cost was ten cents per kilowatt-hour, which, at the rate of 131 watt-hours per foot drilled, is equal to 1.3 cents per foot. The minimum cost of drilling with steam or compressed air is equal to ten cents per foot.

VENTILATION.

There are not many instances as yet in this country of electrically driven fans in mines. At the Pelton Colliery, Durham, a fan by Davidson & Company, Limited, of Belfast, has replaced two steam-driven Guibal fans. The fan motor absorbs about 154 brake-horse-power, removing 223,054 cubic feet of air per minute. On tests of Guibal fans the two removed 199,745 cubic feet of air per minute, and absorbed about 178 brake-horse-power. The gain in favor of the single electric fan of upward of 23,300 cubic feet of air per minute, with an expenditure of twenty-four horse-power—less a reduction of 13.5 per cent—is very creditable. Moreover, a set of boilers, burning coal, and two steam engines were dispensed with, and an existing boiler fired with coke-oven gases was used.

LOCOMOTIVES.

Pneumatic locomotives are very clumsy affairs when compared with electric ones. Their excess in bulk and weight is largely due to the big cylinders of compressed air which they must necessarily carry. In consequence they are not so suitable as electric locomotives for low seams, save where considerations of firedamp make their use the more safe. There must be sparking at wheels of compressed-air locomotives when skidding at starting or on gradients. It has been proved in South Wales that these sparks will ignite gas. Electric locomotives are not much used for collieries in this country, the sparking at the trolley wire being inadmissible; but even if compressed air is employed, electric driving is best for the compressors.

In up-keep of locomotives, electricity is far more economical than compressed air.

FIRES FROM ELECTRICAL CAUSES.[1]

BY C. B. ROULET.

The use of electricity for lighting and power is a very new industry. The means of offence always comes first, defence comes after—always a little behind the times—and the more they grow and develop, the nearer they approach equality. This is true of electricity; its first growth was very rapid, and little, if any, care was taken to surround it with even the ordinary safeguards, but as time went on we had time to catch up with the infant industry, and we are now getting to the point where our means of defence are getting somewhat nearer an equality with its means of offence. The first printed rules covering electrical installations were issued by the New York Board of Fire Underwriters in 1881. It was the practice then to staple up bare wires for arc lights and to neglect the very important safeguard of enclosing the carbon, which then, as now, would throw off sparks of white-hot particles of carbon. It was at this time that the underwriters generally were beginning to understand that some steps must be taken to safeguard this new application of an old form of energy, and the Electric Light Association also began to recognize the fact that they must cooperate with them if they desired to develop their industry to its legitimate extent. They saw that if the use of their product was to be dangerous to life and property they could not hope to introduce it to any great extent. It was their duty to do their utmost to convince not only the underwriters, but the general public, that electricity could be so used as not to unduly jeopardize either life or property.

From 1885 to 1890 each underwriters association had issued rules to suit themselves—all contained good points—but no two alike. In 1890 a joint committee from all the underwriters, electric light associations and such other associations as were interested in electrical construction work, was appointed to formulate a code of rules. This committee was composed of men who were broad enough to look at the subject from all standpoints as well as their own, and at this conference the first National Electric Code was prepared.

The rules and requirements as now contained in the National Electric Code are recognized as the standard rules for the safe installation of electric light and power wiring and apparatus, and the standard requirements for the manufacture of electrical devices and materials. Unknown to many, these rules and requirements are prepared, not by the National Board of Fire Underwriters alone, but by the delegates appointed from the well-known national associations. These delegates meet at an annual conference to discuss new systems and devices, prepare rules covering their installations and requirements covering their manufacture, with a view of safeguarding the hazards incident thereto.

During the year of 1904 and the first three months of 1905, the insurance companies paid losses amounting to $4,127,000 on fires due to defective electrical installations; losses footing up $19,857,000 were reported due from this same cause, but were not definitely proven because fire destroyed the conclusive evidence; $2,870,000 of losses reported due from the same cause were on reliable investigation proved to have been due to other causes. The amounts above do not include the fires that were never reported or the loss to owners and occupants, which is at least one-half as large as the above figures. The causes of the fires proved to have been of electrical origin, and which created the above losses, are as follows: 59 due to crosses of low with high-potential circuits; 131 due to grounding of circuits on building fronts, water pipes, metal ceilings and gas pipes which caused arcing, burning of holes through the pipes, and igniting escaping gas; 37 due to lightning being brought inside the building by electric wires, and fires caused by the improper protection offered by unapproved fuses; 62 due to crosses of telephone, telegraph and signal circuits with higher potential circuits; 22 due from burning out of armature or field coils and sparking of dynamos and motors; 5 due to overheated resistances; 15 due to loose terminal connections; 16 due to defective sockets or switches; 24 due to heating of incandescent lamps and setting fire to inflammable material near thereto; 14 due to open link and unapproved fuses; 6 due to short-circuits of wires in fixtures; 63 due to short-circuits of flexible cords; 46 due to overheating of resistances, and defective wiring in electric cars; 14 due to electric heating and cooking apparatus left with the current turned on; 17 due to defective sockets, and the use of flexible cord in show windows.

[1] Abstract of an address on the electrical fire hazard read before the Southwestern Electrical and Gas Association.

Turbine Engines in Gristmills.

Consul Knabenshue, Belfast, Ireland, says that certain mills in that city have employed three steam turbines of 100 horse-power each of the De Laval type since December 12, 1904, to drive their Indian corn milling machinery, and they have proved a success. Two additional turbine engines, of 300 and 200 indicated horse-power, respectively, have been installed to drive all the flouring machinery.

As to the economy of the turbine engines as compared with the old horizontal reciprocating ones, the new installation has not been in operation long enough to determine accurately more than this—that their power is not more costly than the latter.

Improvements in Carbon Filament Lamps.

The London *Electrician* published recently the paper by Mr. John W. Howell, entitled "A New Carbon Filament," which was presented by the author at the recent convention of the American Institute of Electrical Engineers at Asheville. This has led the "Utility" Company, Limited, of London, to state in a communication to the *Electrician,* that it has had in use for the past seven months a process of superheating the carbon filaments, after being flashed, with the most satisfactory results. These lamps are now being tested in independent laboratories. Results of the tests are promised.

Smelting by Electricity.

Vice-Consul-General Gorman, of Montreal, reports that the Dominion government has appropriated $15,000 for making experiments with the electric process of smelting ores and manufacturing steel at Sault St. Marie, and the Consolidated Lake Superior Power Company will furnish a building and dynamo capable of supplying 400 electric horse-power for four months free of charge. All kinds of ores will be experimented with, and important results are expected to be obtained.

Great possibilities for Canada underlie the inauguration of a cheaper process for manufacturing pig iron and steel than is now in use. Ontario is dotted with ore bodies, the development of which is at present prevented by lack of cheap fuel. There is coal in the eastern and western parts of Canada, but the cost of conveying it to points where coke is needed for smelting purposes is prohibitive. On the other hand, there are a great many water powers throughout the provinces of Ontario and Quebec where electricity can be developed and utilized. If the electric system proves to be commercially feasible Canada is looking for the inflow of a large amount of capital and considerable mining development.

The Hydroelectric Plant at Beznau.

An Important Swiss Central Supply Station.

By C. L. Durand.

AMONG the large hydraulic plants which have been installed in the Rhine region during the last few years may be reckoned the station which takes its power from the Aar river at Beznau. The hydroelectric plant is located at a point which lies some four miles from where the Aar flows into the Rhine. The dam which is built across the river at a mile or so from the turbine station provides a head of water which varies from eleven feet in the summer season to nineteen feet during the winter months. As will be observed in one of the engravings, the dam is built of six stone piers, two of which lie next the shore. Between the piers is a series of iron gates which run in grooves in the masonry and can be raised or lowered. A long bridge runs across the top of the piers, built of iron trelliswork. Mounted on this structure is the hoisting apparatus which is used for each of the gates. The construction of the dam at Beznau is almost the same as the great dam across the Rhone near Geneva which supplies the hydraulic station of Chèvres.

At a mile or so below the dam is the handsome building which has been erected to contain the turbines. It is divided into two stories. The lower part contains the chambers for the alternator and the exciter turbines, which are built in cement. The vertical shafts of the turbines pass up through the flooring into the long hall which contains the dynamos.

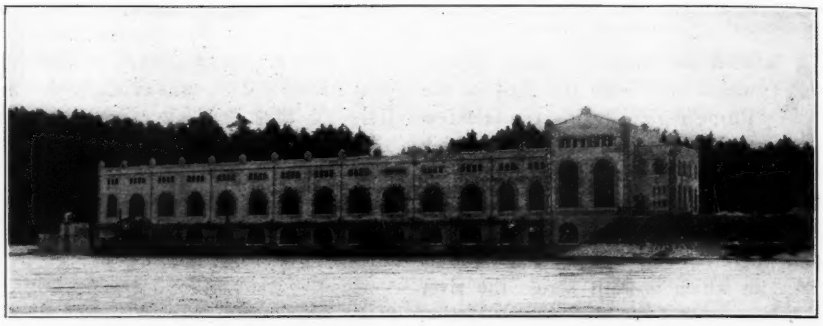
It is to be remarked that the central station of Beznau owes its importance mainly to its situation with respect to the great industrial centres of the region. Within the district which is covered by the high-tension lines of the station we find the important localities of Zürich, Winterthür, Aarau and others. Besides, the station is connected with Rheinfelden, where there is already a large hydraulic plant. Owing to the good distribution of the overhead lines of the present system, combined with the use of a high tension, the plant can furnish light and power to the industrial centres which are situated even at a great distance. The line runs eastward from Beznau for a distance of forty miles, running along the lake of Zürich and taking in that important centre. Another line goes the other way for nearly an equal distance and covers the region in the direction of Rheinfelden. A third circuit goes southward to Entfelden, near Aarau and the lake of Hallwyl. These lines all pass through large towns and villages and thus cover an extensive district which has the benefit of the current.

The power of the fall is utilized by vertical turbines which are built by the well-known Swiss firm Theodore Bell & Company, of Lucerne. The turbines to the amount of 10,000 to 12,000 horse-power are direct-coupled to alternators of high tension. These machines, with the exciters and the extensive switchboard apparatus which the station contains, have been furnished by the Swiss firm Brown, Boveri & Company, which has equipped a great number of hydraulic plants in different parts of the country.

One engraving shows a view taken in one end of the main dynamo hall, and there may be observed the arrangement of the direct-connected three-phase alternators. When the station is equipped to its full capacity it will have eleven alternators of the Brown-Boveri pattern, such as are seen here. These machines are of the most recent type which that firm constructs. The field lies on the outer part and forms a large ring. The circular casting which forms the main body of the machine and is supported on the flooring contains a laminated and slotted ring on

VIEW OF ALTERNATORS, BEZNAU HYDROELECTRIC STATION.

the inside, into which are fitted the armature coils. The latter are formed of a copper bar winding in three circuits, one for each phase. The field of the alternator is formed of a ring which revolves inside the armature, and is made up of a circular iron casting made in two halves and bolted together, having mounted upon it a set of projecting pole-pieces. These latter receive the field coils of the usual form. The Brown-Boveri company has adopted the system of placing the bearing of the main shaft below the revolving field, instead of having it supported at the top by a cross-bracket. This arrangement brings the bearing lower down, and thus diminishes the length of the main shaft which lies between the bearings of the machine. As will be noticed, the shaft projects above the main bearing and in order to carry the revolving part which lies somewhat lower down, a set of sloping arms is employed to mount the ring upon the shaft. From its form, this type of alternator is known as the "umbrella pattern." It has proved superior to the machine which has a top bearing for the shaft, and all the new alternators which the company builds are now made on this plan.



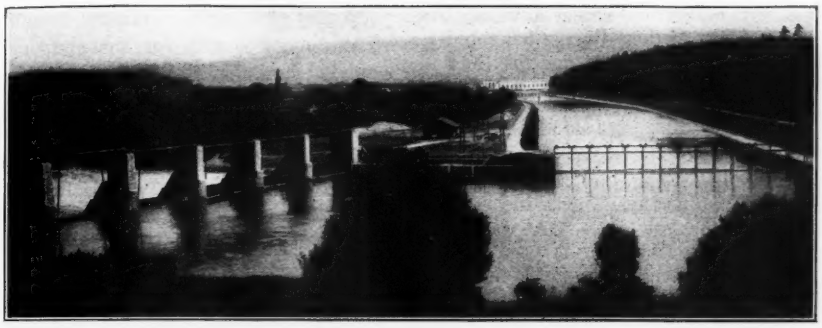
HYDROELECTRIC STATION AT BEZNAU, SWITZERLAND.

The machines at Beznau are all alike, and furnish some 1,000 to 1,200 horsepower each. They operate at 66.6 revolutions per minute, and the three-phase current is produced at a voltage of 8,000 and a frequency of fifty cycles. At present, six of these alternators are already set up in the dynamo room, and three others are now building and are soon to be erected. Beside each alternator will be noticed the hydraulic regulator which is used to govern the speed of the turbines. The apparatus is connected by a set of gears and shafting below the floor with the main turbine shaft. Movement is given to two powerful hydraulic pistons, each working in a cylinder, according to the speed of the mechanism. The pistons work a set of rods and levers which pass down to the vanes of the turbines. Any change of speed thus causes the supply vanes to

VIEW OF DYNAMO ROOM, EXCITERS IN THE FOREGROUND, HYDROELECTRIC STATION AT BEZNAU, SWITZERLAND.

open or close and thus keep the speed constant within very close limits.

The exciting current is furnished to the alternators by the machines which are observed in another view. These exciters are mounted each on a separate turbine and have a capacity of 400 horse-power. They supply current at 200 volts. These exciters are of substantial build and have a top bearing which is held upon four arms coming from the main field ring. On the right are the turbine regulators.

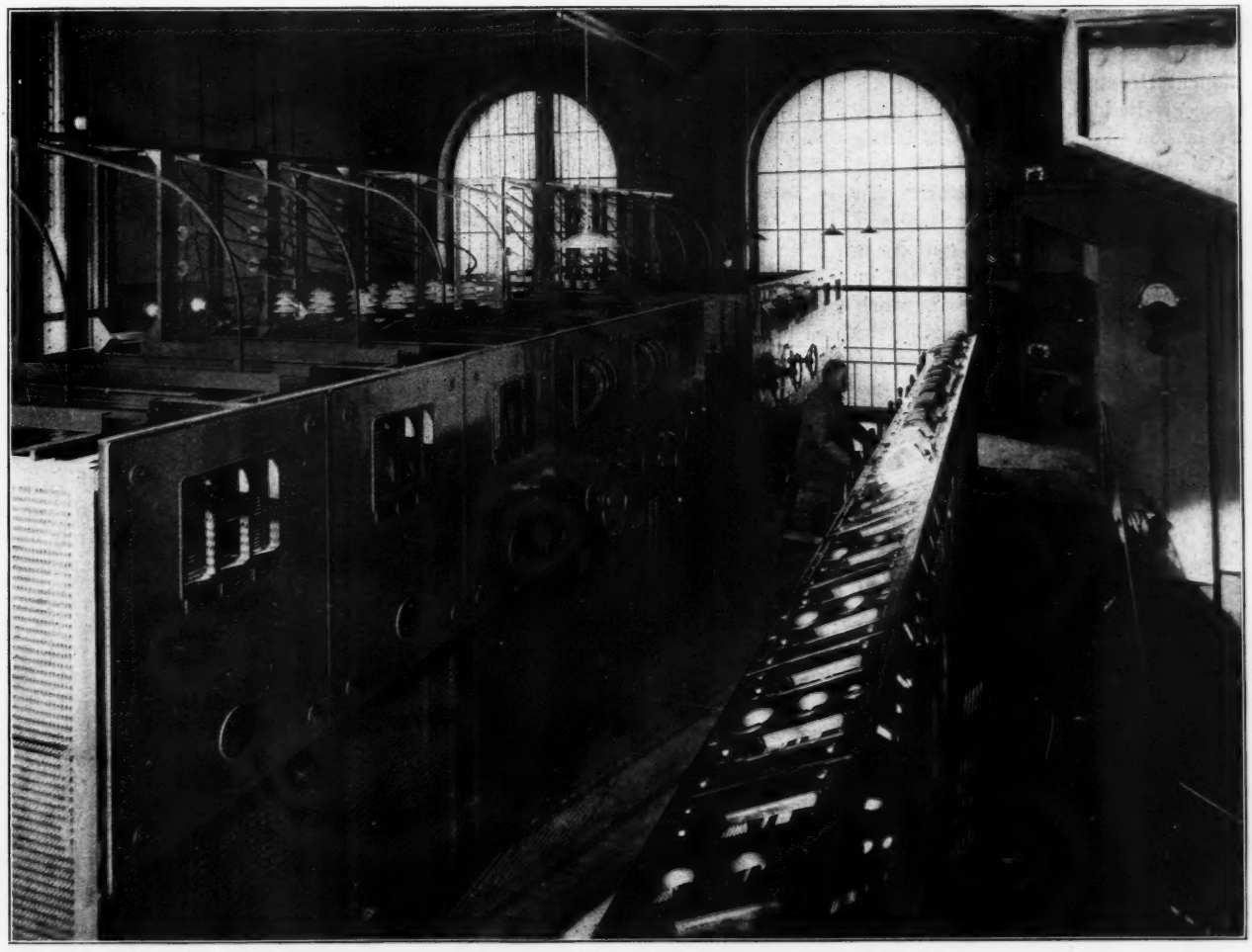


THE DAM, HYDROELECTRIC STATION AT BEZNAU, SWITZERLAND.

Besides the voltage of 8,000 which is used to supply the localities not far away from the main station, the distant points of the region are provided with a high-tension line which uses 25,000 volts. The station contains a bank of transformers for raising the voltage of the machines to 25,000 volts. These transformers, of the three-phase Brown-Boveri pattern, have a capacity of 910 kilowatts each. At present there are two of these transformers mounted in the station.

Current is generated in the Beznau plant for motors in different industrial work in the region as well as for electric traction and lighting. To operate these different circuits the station is equipped with two sets of bus-bars working at 8,000 volts. One set of bars is used to feed the lines which have a variable load. The second set furnishes current where the loads are nearly constant. However, the two systems can be thrown in parallel and besides the station has switching apparatus by which each alternator and each transformer can be coupled to one or the other set of bars.

As to the high-tension lines at 25,000 volts, there are four of these circuits either in use or in project. First, a twenty-eight-mile circuit going to Rheinfelden, formed of three wires of seven millimetres. The substation at Rheinfelden is laid out for 3,000 horse-power and is designed to help out the hydraulic plant which already exists on the Rhine at this locality. Second, a line passing to Entfelden (twenty-two miles) with a branch running to Boniswyl. This line has three



PART OF ALTERNATOR AND MAIN LINE SWITCHBOARDS, BEZNAU HYDROELECTRIC STATION.

eight-millimetre wires. The main substations at Entfelden have a capacity of 500 to 800 kilowatts and those which lie at Boniswyl, about the same power. These stations lower the line voltage from 25,000 to 8,000 volts. From here the 8,000-volt circuits run to a certain number of transformer posts which are situated in the neighboring localities. Third, two lines going to Seebach, a distance of twenty-three miles. Each line is formed of eight three-millimetre wires. These circuits come at Seebach to a substation and from here they continue in different directions toward Zürich, where the line is provided for 3,000 kilowatts, and to Grunningen (3,700 kilowatts), and it is proposed to run a circuit to the important centre of Winterthür which will take some 2,000 kilowatts. The above-mentioned substation at Seebach is equipped with transformers to the extent of 1,600 kilowatts and distributes current at 8,000 volts in the neighboring centres. A substation at Grunningen has a similar arrangement. Besides the high-tension lines, a low-tension circuit of 8,000 volts is run from the hydraulic plant to Baden and other localities near the station. To handle the different circuits at 8,000 and 25,000 volts, the Beznau station is equipped with a very extensive set of switchboards. In our engraving, which shows but a small part of the outfit, the left-hand switchboards are used for the light and power lines. To the right, the attendant is operating the alternator switchboard.

The "Horn" Lightning Arrester.

The "horn" lightning arrester, says N. J. Neal in the *Electric Journal* for August, bases its operation on the fact that the short-circuits once started at the narrow gap between the horns will travel upward, due to the heat developed, until the arc breaks. A certain amount of time is required to do this, something like two seconds, and on large plants the resulting short-circuits are not only objectionable, but in many cases, where synchronous apparatus could fall out of step, would be prohibitive. Descriptions are given of three American installations of this arrester. The first to be constructed was built by the Standard Electric Company to protect its plant at Electra. Horns are formed of No. 0000 copper wire supported on the regular line insulator. A water resistance is used, consisting of strips of copper immersed in a salt solution contained in jars having a capacity of about fifteen gallons each. This water is covered with one-eighth inch of oil to prevent evaporation. A choke coil is also used consisting of about eighteen turns of iron wire around a six-inch cylinder. This installation was designed by Mr. A. C. Bunker who lays great stress on the curve at the knee of the horn and on the angle at which the horns diverge. If they diverge too rapidly, the arc will hang on and not rise, and if the knee be too sharp, the arc will be re-established after breaking, or will fail to rise. The American River Electric Company constructs its horns of galvanized iron gas pipe. They are separated by a gap about two and one-fourth inches long for the 40,000-volt lines. A water resistance covered with oil is used in the ground connection. Pure water has been found to be as satisfactory as a salt solution. The Shawinigan Water and Power Company is also protecting its lines by means of horn arresters.

New English Single-Phase Traction Motors.

During the recent meeting of the Incorporated Municipal Electrical Association in Great Britain, a new type of single-phase motor constructed by Bruce Peebles & Company, of East Pilton, Edinborough, was exhibited to the members. The motor is of the compensated repulsion type. For a two-pole field there are four brushes, two carrying the main current and the other two being short-circuited. To simplify the construction, one of the four brushes has been discarded in a recent improvement, leaving but three placed approximately 120 degrees apart. Two of these brushes are short-circuited, thus acting as the brushes for the repulsion action, while the pair together acts as a single brush for carrying the main current. In still another type, control is obtained by means of an induction regulator acting upon the field of the motor. The stator consists of a high-potential winding which acts as the primary of the transformer, the secondary of which supplies low-voltage current to the armature. The advantages of this arrangement are said to be simplicity, lightness and efficiency equal to that of any other system, while giving a higher power-factor.

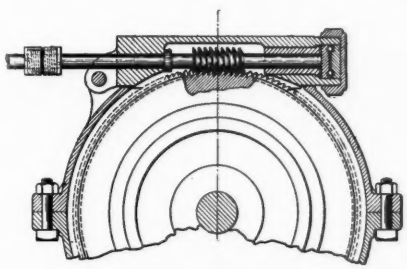
Another development in single-phase motor field is described in a recent English patent allowed to Mr. T. von Zweighbergk. This patent covers a method of using two single-phase commutator motors which are coupled so as to produce a large torque. The motors are connected in parallel, a small direct-current generator being connected in the circuit between them. When an alternating current is supplied to this arrangement, it will flow through the two motors in parallel. At one particular moment this alternating current will be aided by the continuous current in one branch, and opposed by that in the other. In the former a large current will be able to flow, exerting a correspondingly large torque. In the next moment the conditions are reversed, the other motor developing a large torque.

The Conductivity of Copper.

A great deal of work in the line of producing copper castings has been done in the last few years, intended for electrical purposes, says *Metal Industry,* and one of the requirements for that particular case is that the electrical conductivity should be as high as possible. Little was, however, known with regard as to how small amounts of various other metals present in the copper would affect the electrical conductivity of the latter, as the investigations carried on in that line had been mostly confined to the study of the variations brought about by the presence of larger amounts of other metals. Recently, however, Mr. L. Addicks has been conducting experiments in that line, and his results are of much interest. Among the metals which he tried were aluminum, phosphorous and silver, and the results are very interesting when considered in their bearing upon the question of the various deoxidizers, which are currently used in order to obtain homogeneous copper castings. He finds, for instance, that an addition of 0.006 per cent of aluminum brings the conductivity down to 98.6 per cent, while 0.109 per cent lowers it to 66.8 per cent and 0.739 per cent of aluminum lowers it as far as 43.5 per cent. Phosphorus has a still more deleterious action on the conductivity of copper, inasmuch as the addition of 0.080 per cent was sufficient to lower the conductivity of the copper to 52.3 per cent, showing conclusively that when phosphorous is made use of as a deoxidizer in copper castings, the conductivity is bound to suffer considerably. Silicon, on the other hand, showed an entirely different behavior. When added in amounts of 0.007 per cent, in one case it lowered the conductivity to 99.4 per cent and in another case to 99.1 per cent, while an addition of 0.042 per cent failed to bring the conductivity down to lower than 99 per cent. The factors which express the ratio of the lowering of the conductivity to the amount of impurity present vary therefore very widely, it being 3,000 for phosphorus and only seventy for silicon, while the factor for aluminum is 500, showing that the latter is also considerably more hurtful in its influence on the electrical conductivity than silicon. The results thus obtained are of considerable interest, inasmuch as they show definite numerical values of the influence of the three substances on the conductivity of copper, and thus substantiate the claims made for silicon in this connection, which had been found to be the case in practical working.

Electrical Patents.

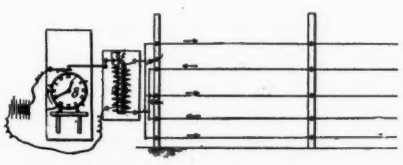
A ratchet worm-gear is the invention of Theodore E. Button, of Schenectady, N. Y., and the patent (795,337, July 25, 1905) obtained thereon has been assigned to the General Electric Company, of Schenectady. The invention has for its object the provision of means whereby a ratchet engagement between the driving and driven element in a train of worm-gearing may be secured. The invention is used in connection with a switch mechanism described and claimed in a patent to Hewlett, No. 755,771, granted March 20, 1904. In this type of switch, the desired object is to produce a wide separation of the points of contact rupture as quickly as possible and to do so at a point of safety for the operator. This



RATCHET WORM-GEAR.

is accomplished by means of a motor which stores energy in a separating mechanism as it moves the terminals into contact with each other and which is provided with means for disconnecting or unclutching the motor from the separating mechanism so that the latter may act instantaneously. A drive shaft is provided to which a ratchet worm is yieldably coupled. A ratchet worm-wheel is mounted for engagement with the worm, and means are employed for storing energy in the wheel as it is driven to a predetermined position in one direction. Means are also provided for instantaneously releasing the energy when the wheel passes this position.

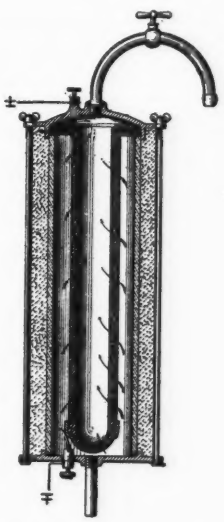
An electrically energized fence has been patented (796,241, August 1, 1905) by Mr. Albert Duy McNair, of Dallas, Tex.



ELECTRICALLY ENERGIZED.

The invention relates to fences and admits of general use, but is of special value as applied to fences intended to prevent the escape of animals, such as cattle, horses, and hogs, therethrough. The invention further relates to means for exciting the wires of the fence electrically, so as to give the animals an electric shock upon making the proper contact with the wires. The invention also relates to time-controlled mechanism for rendering the electric action of the fence intermittent, so as to save the battery current. In carrying out the invention, a Ruhmkorff coil is provided with a primary winding and a secondary winding. A fence is connected with the secondary winding and a circuit is employed for energizing the primary winding, this circuit being provided with a contact. Time-controlled mechanism is employed for throwing the primary winding into and out of circuit.

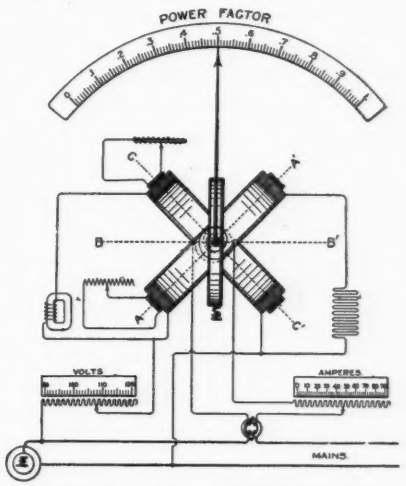
Eugene A. Byrnes, of Washington, D. C., has invented a process (795,956, August 1, 1905) of electrically heating water and other liquids. According to Mr. Byrnes's process, water and other liquids are heated by electrically heating a porous or granular resistance conductor and passing the liquid into or through the



ELECTRICAL HEATER.

heated conductor, thus exposing a large heated surface to the liquid in the interstices of the conductor.

The Duncan Electric Manufacturing Company controls a patent (796,032, August 1, 1905) recently granted to Thomas Duncan, of Chicago, Ill., for an electrical measuring instrument. The invention relates to systems of alternating-current distribution, and has for its object the provision of an instrument for measuring and determining without calculation the power-factor or difference in phase between the current and impressed electromotive force on working circuits. It is desirable to have the electricians at the general stations informed concerning the phase of the current with relation to the pressure. Generally speaking, the invention comprises a measuring element and motor means which is caused to operate upon a change in phase relation of the current and pressure to effect an actuation of the measuring element to indicate the difference of phase between the current and pressure. In the preferred



ELECTRICAL MEASURING INSTRUMENT.

embodiment of his invention, Mr. Duncan employs two windings which are subject to the pressure of the system and which produce magnetizing effects differing in phase, preferably by ninety degrees and a third, a current winding, which produces a magnetic field varying in phase with the current in the system and by coaction with the pressure fields effects a location of the measuring element that indicates upon a scale the phase relation of the current in the main circuit with the pressure impressed upon that circuit. One of the pressure fields is preferably maintained in phase with the impressed pressure, while the other pressure field is maintained in quadrature with the impressed pressure.

Maryland Telephone Company Can Furnish Lights.

The Court of Appeals of Maryland has delivered an opinion, affirming the decision in the Circuit Court, in the case of Alexander Brown against the Maryland Telephone and Telegraph Company, of Baltimore. By the decision the telephone company is sustained in its claim of the power to furnish electric light to the city of Baltimore under such regulations as the mayor and city council may prescribe. The single question presented by the appeal was whether or not the Maryland Telephone company has the power under its charter to do an electric lighting business in Baltimore.

Reviews of Current Engineering and Scientific Literature.

The Future Supply of India-Rubber.

The possibility of increasing the supply of india-rubber is discussed here by Mr. H. L. Terry. The bulk of the raw rubber supply comes at this time from Brazil and the Congo region, the main point with regard to future supplies being that in Brazil the product is obtained by merely tapping the trees without affecting their vitality, while in Africa, the plant, which is a kind of creeper, is cut down and destroyed in the gathering process. Unless replanting is adopted, it is only a matter of time for the total exhaustion in the principal yielding grounds of West Africa to occur. On the other hand, the Brazilian tree continues to yield, requiring practically no oversight or capital outlay. There is plenty of this Brazilian rubber, which is of a much higher grade than the African, to be had, but the difficulty is to get sufficient labor to gather it in order to keep up with the constantly increasing demand. If an unlimited supply of acclimatized labor were available, there would be a decline in the present price of rubber. Given favorable conditions, the Para rubber tree can be grown in Ceylon and the Straits Settlements at a cost of fifty cents per pound of pure rubber. Plantation-grown rubber commands a higher price because of its freedom from water. It is not supposed to be better intrinsically, but is harvested in a better manner. It seems to be a demonstrated fact that plantations laid out scientifically and under good management yield a handsome profit in seven or eight years. In Mexico and Central America the indigenous tree, *Castilloa,* is being extensively planted. It gives a good rubber, and under cultivation will command higher values than that prepared by the natives, but there is no ground for supposing that this rubber will be equal to Para rubber in price. At the present time the amount of rubber from cultivated sources is not enough to affect the price.—*Abstracted from Electrical Review (London), July* 21.

The Galbraith Electric Iron and Steel Furnace.

Description is given here of the new electric furnace invented by Messrs. J. K. S. Galbraith and W. Steuart. The furnace was brought out to deal with the iron sand found at Taranaki bay in New Zealand, which heretofore has been useless due to lack of a satisfactory method for smelting it. The sand is so fine that ordinary methods of reduction do not cause the grains to flow together. It is, however, very pure, and since it is magnetic, it can be further purified in a magnetic separator. The main features of the process are the following: the iron sand mixed with carbon is passed through a furnace so as to fall as a shower in a zigzag path through a number of carbon grids heated electrically. The sand is thus melted and reduced and is caught in a suitable receptacle below. The whole furnace is sealed preventing the entrance of air as otherwise the grids, or incandescents as they are called, would be destroyed. The charge is met in its downward path by reducing gases. Low potential is used, about eighteen volts. The product collects in the receiver in the shape of beans and is said to be free from the titanium contained in the ore. The furnace itself is built up of a framing of graphite holding horizontal grids, likewise of graphite. The grid bars form obtuse angle roofs. Four of these grids are confined in one tier, and there are three tiers, one above the other. The charge thus passes over the twelve bars in succession before falling into the receiver. Between the bars, or incandescents, interceptors are placed. Current is introduced into the incandescents by means of iron bars pressed against their machined ends. The twelve grids are connected in parallel. A furnace of this type was shown recently in operation at Longhborough, England. It consumed 100 kilowatts and is said to be capable of dealing with about eighteen ounces of iron sand per minute, or 280 tons per year, working continuously.—*Abstracted from Engineering (London), July* 31.

Modern Power-Plant Design and Economics.

This is the first article of a series written by Mr. Franz Koester in which American and European practice in power-plant design will be compared. The present section deals with the general features of the design of large power stations. In Europe this work is made a specialty by certain engineers who take it up as a branch by itself. In America practice is otherwise, many large plants being constructed by newly formed companies which employ one or two experts and a large force of men untrained in this particular work. This difference in practice, it is thought, accounts for the greater economy which has been attained in certain European stations. In modern plants there the steam consumption has been reduced, in some cases to nine or ten pounds of steam per indicated horse-power-hour, while in this country and in England a consumption of thirteen to fifteen pounds is considered good. Part of the superiority is also due to the continental manufacturer and to the power-plant manager. The tendency abroad as well as here is toward one large generating station with distribution from substations. In Europe the buildings are made to harmonize with surrounding property and much attention is given to the interior decorations. The general lay-out is the same everywhere, but in certain countries abroad it is required by law that all the boilers be placed on the ground floor. In France the marine type of water-tube boiler has been adopted to reduce the floor space but wide passages are left between rows of boilers. The introduction of the steam turbine has made a modification of the arrangement of boiler desirable, and this has been met in the same way both here and abroad. The necessity of economizing in floor space is not so great abroad as it is here as land is cheaper there and European power plants are usually constructed of one story. On the Continent large office equipments are often found directly in connection with the power plants. Where the location of the plant is on soft ground, piles are usually satisfactory, but not always so. A case is mentioned, in Holland, where the entire plant, building and all, moved two inches in the direction of rotation of the engines. This might be prevented by installing the units so that alternate ones revolve in opposite directions.—*Abstracted from Engineering Magazine (New York), August.*

The Phenomena of the Singing Arc.

An investigation of the singing arc made by M. A. Blondel is discussed fully here. The generally accepted explanation of the singing arc is that it is due to resonance of some kind established in the circuit. This condition may be obtained with inductances and capacities of varying size, but it seems to be necessary that the sum of the difference of the voltages

measured across the inductances and the capacities shall be greater than the voltage measured at the terminals of the arc. It is thought that the following conclusions are new: there are two different types of singing arcs which have heretofore been confused. One is continuous, the other discontinuous. The continuous singing arc seems to be due to ionization of the vapor. It is produced in long arcs. The discontinuous arc is more generally observed, for it is obtained with electrodes of carbon or of metal. The frequency of the singing arc is essentially variable and poorly defined. In the continuous arc Duddell's formula enables it to be determined approximately. On the contrary, there seems to be no relation between the frequency of the discontinuous arc and the fundamental frequency of the circuit. The composition of the supply circuit always plays an important part in this phenomena. It is suggested that the singing arc may find useful application for producing sinusoidal waves of frequencies from 200 to 1,000 per second. Such currents may be useful in medicine, or they may be used for measuring small inductances. In the latter case, however, the uncertain frequency is a disadvantage. High-frequency currents can be obtained by means of the hissing arc having a small gap. It is said that frequencies as high as 196,000 are obtainable, but the author has not succeeded in getting above 100,000. The high-frequency currents could be used in wireless telegraphy, but they give rise to an enormous loss of power. Frequencies as high as 1,000,000 might be obtained if the arc be placed in a vacuum, but with a frequency as high as this wireless telegraph stations would require an equipment of several thousand horse-power. For medical purposes high frequencies from 100,000 to 200,000 are best obtained by means of metal electrodes. —*Translated and abstracted from L'Eclairage Électrique (Paris), July 15 and 22.*

The Design and Operation of Ball-Bearings.

A very complete study is given here by M. C. Gargauff of the proper conditions to be obtained in the design and operation of ball-bearings. The author has conducted a large amount of experimental work in order to determine the relative efficiencies of different types of ball-bearings, and to compare them with the ordinary sleeve bearing. The method of testing consisted in using the outer sleeve of the bearing as a brake, in order to measure the turning effort exerted upon the bearing when the shaft is in motion. A satisfactory brake consists of a strap of soft steel to each end of which a weight is attached. The size of the weights determines the load on the bearing and the turning effort is measured by adding an additional weight to that side which tends to rise. Ball-bearings are divided into four types. The first is that in which the balls touch at but two points. Bearings of this type may offer a resistance to turning only about one-thirtieth of that offered by the ordinary sleeve bearing. This resistance is due to the friction caused by the complicated motion of the balls. Since in practice, contact is made by a surface and not by a point, slipping must take place and this gives to the ball a rotary motion in addition to that around the sleeve. The second type of ball-bearing is that in which the balls touch at three points. The resistance due to such bearings is from two to four times that of the bearings of the first type. Bearings of the third type are those in which contact is made at four points, the points of contact being placed symmetrically with respect to the path followed by the balls. Such bearings give rise to friction from four to eight times that due to bearings of the first type. Bearings of the fourth type are those in which contact is made at four points not arranged symmetrically. Such bearings give rise to much more friction from two to four, or even six times that due to bearings of the third type. The author has found that in general the coefficient of friction decreases with an increase in the size of the balls, but a limiting point is reached after which an increase in size increases the coefficient. The best proportion determined experimentally is given by the following empirical formula: the diameter of the ball should equal to the diameter of the shaft divided by seven, plus two millimetres. Tests to determine effect of speed on friction have shown that at low speeds it is two or three times that at moderate speeds. For a higher range of speeds the coefficient of friction is nearly constant, but as very high speeds are reached it begins to increase. At 10,000 revolutions per minute the coefficient is about double that at 6,000 revolutions. At 14,000, it is quadrupled, and at 17,000, it is about ten times as great. This is the maximum value reached as it was found that above this speed the shaft slips on the balls. The increase in friction due to high speed is attributed to centrifical action which greatly increases the pressure of the balls on the collar. Separators introduced to enable a smaller number of balls to be kept properly spaced increase the frictional resistances. Oil does not act as a lubricant in the sense of reducing the friction, but it is necessary since it takes up dust and grit which get into the bearing and thus prevents excessive wear. From the fact that oil does not reduce friction in a bearing, it is concluded that the friction due to the rubbing of adjacent balls against one another is negligible. The removal of a single ball from a bearing containing twenty increases the power, absorbing about four per cent. The limiting load depends upon the speed and is given by the following formula: the product of the load per unit length of bearing into the linear velocity must not exceed the figure twenty.—*Translated and abstracted from L'Industrie Électrique (Paris), July 25.*

Valuation of Telephone Property in Indiana.

The Indiana state tax board has made public its preliminary assessment of telephone property in the state. The report indicates that the board yields to the plea of some of the larger companies for a reduction. Among the 350 telephone companies doing business in Indiana, perhaps the most noticeable decrease was made in the return of the Central Union Telephone Company's assessment from $54 to $40 a mile, making a total decrease in value of that company of almost $813,000. Another large decrease was made in the case of the Indianapolis Telephone Company, listed last year as the New Telephone Company, at $160 a mile, this year is dropped to $100 a mile. The assessment for the New Long-Distance Telephone Company was increased from $30 to $40 a mile, while the American Telephone Company, carrying the long-distance business of the Central Union, remains the same $40 a mile.

The United Telephone Company, Bluffton, was increased from $70 to $110 a mile; Delaware & Madison County, Muncie & Anderson, from $105 to $135 a mile; South Bend Telephone Company, from $90 to $100 a mile; the Logansport Home Telephone Company, from $30 to $35 a mile, while many other companies remain the same as last year. The assessment of the Cumberland Telephone Company, doing business in southern Indiana, was decreased from $60 to $50 a mile. The mileage during the year has been greatly increased and many plants rebuilt with better material and equipments.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

New Parallel Rod Edgewise-Wound Type of Direct-Current Power-Circuit Lamp.

The General Electric Company, Schenectady, N. Y., has recently placed on the market a direct-current, power-circuit arc lamp similar in design to the parallel rod edgewise-wound multiple lamp. This new lamp, which is shown in the accompanying illustrations, embodies all of the advantages of the parallel rod design and at the same time has distinctive features which make it more desirable than the usual differential power-circuit type of lamp.

The new lamp is designed for use two

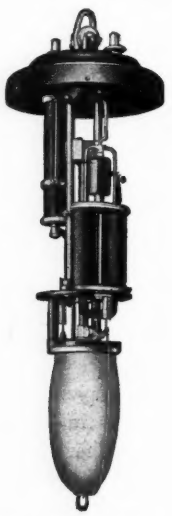
NEW PARALLEL ROD, EDGEWISE-WOUND, DIRECT-CURRENT LAMP, WITH EXTERNAL CUTOUT.

in series on 220 volts or five in series on 550 volts, and it can also be operated singly on 110 volts by removing the regulating weight that forms part of the lamp mechanism. It is recommended for use on 220 volts, where permissible, in preference to the 220-volt multiple lamp, on account of its higher efficiency and better quality of light.

The parallel rod construction for arc lamps has been well known for some time, and many thousand lamps of this design are in successful operation. The lamp has obtained its name from the fact that the two main castings, top and base, are connected by two parallel steel rods. The magnets are mounted upon the lamp base, and the adjusting resistance is supported between the top and the base. The mag-

NEW PARALLEL ROD, EDGEWISE-WOUND, DIRECT-CURRENT LAMP.

nets and resistances are all parallel to the main connecting rods; an arrangement which presents a most attractive appearance. All who have had experience with

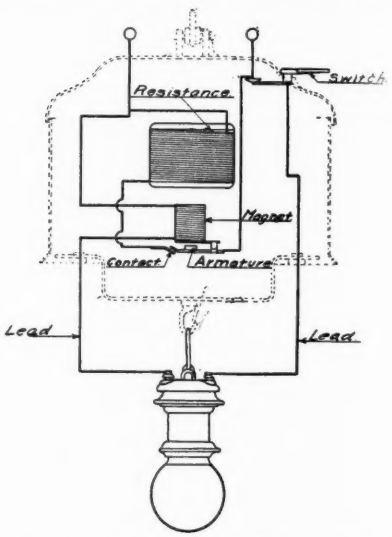


INTERIOR MECHANISM, NEW PARALLEL ROD, EDGEWISE-WOUND, DIRECT-CURRENT LAMP.

the multiple lamp will recall the novel construction of the windings for the magnets and resistances. These windings are produced by winding ribbon wire on edge and insulating the consecutive turns with non-combustible material. This construction, which has been followed in the new power-circuit lamp, is practically indestructible.

In the design of the new lamp, the number of insulating and other parts has been reduced to a minimum. All necessary insulating pieces have been so designed as to ensure mechanical strength as well as good insulating qualities. Particular attention has been paid to the insulation of the frame from the current-carrying parts. The insulating pieces are of porcelain, the number of small bushings and mica washers having been reduced to a minimum. The absence of lead wires is very noticeable, there being only one flexible cable (insulated with glass beads) in the lamp. With this construction, the insulation of the lamp is nearly ideal.

To adapt the parallel rod lamp to operation in series on power circuits, an im-



CONNECTION DIAGRAM, NEW PARALLEL ROD, EDGEWISE-WOUND, DIRECT-CURRENT POWER-CIRCUIT LAMP.

proved mechanical device has been designed to maintain the proper voltage relation among the various lamps of the series. Suspended from a lug in the lamp top and projecting downward is a bell-crank lever having one arm weighted and the other attached through a connecting link to the top of a frame carried by the magnet armature. The distance of the weight from the fulcrum of the lever is adjustable. The object of this adjustable weight is to counteract any tendency toward unequal arc lamps caused by so-called "stealing of voltage." By this simple mechanical device, the regulation of the lamp is obtained without the employment of the shunt magnets which are used in the differential type of power-circuit lamp.

Another advantage, gained by the me-

chanical regulation above described, is the ability of the lamps to operate satisfactorily over a wide range of voltage. It is of particular interest to note the individual voltage regulation of five lamps, operated in series on the nominal 500-volt power circuit, as the voltage of the power circuit varies between wide limits.

The only resistance used in the new power-circuit lamp is an adjusting resistance, the cutout resistance, which is so common with other lamps of this type, having been omitted. While the failure of any lamp of a series unprovided with cutouts will cause the entire series to go out, such failure is extremely unlikely with the new power-circuit lamp, as the simple construction of the lamp renders it thoroughly reliable. However, an individual cutout is furnished when desired. The cutout, which is an entirely separate device from the lamp itself, is connected in series with the lamp and hung directly over it. In operation, a small controlling magnet, in series with the lamp, releases its armature when the lamp goes out, thereby placing the cutout resistance in circuit.

The arrangement and connection of this cutout is shown in the accompanying diagram. The device constitutes a very compact form of substitutional resistance, which can readily be connected to the lamp circuit if required.

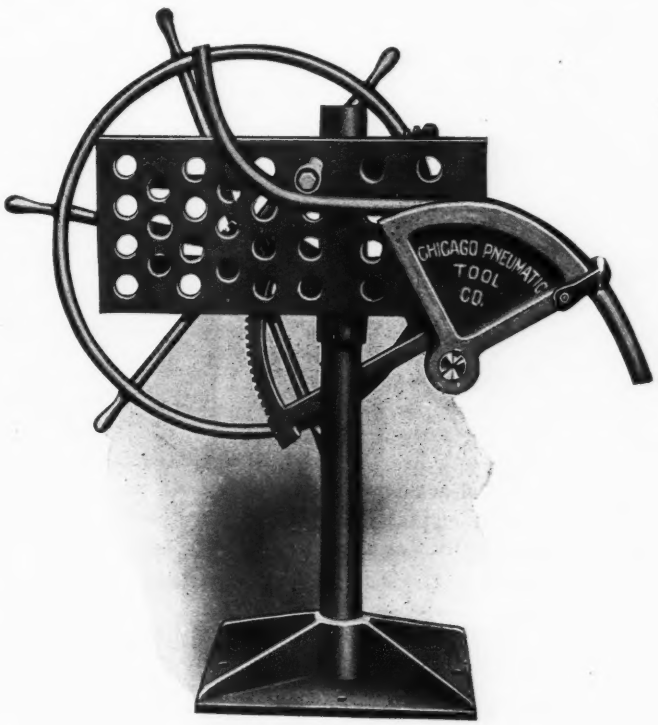
The simplicity of the construction of the parallel rod lamp ensures a low maintenance cost, and this feature will be appreciated in the power-circuit lamp as in other types. All parts are accessible and the adjustment is simple. The lamps can be furnished with either open base or closed base enclosing globes, and when equipped with casings can not be distinguished from other ornamental lamps sent out by the General Electric Company. The usual fittings, such as globes, casings, reflectors, carbons, shades, etc., are interchangeable in all parallel rod and centre-type lamps.

"For California."

The California Promotion Committee, San Francisco, Cal., has issued the electric power number of "For California." This contains a number of lively articles and sketches concerning the electrical developments of California. Some of the articles are: "What Electric Energy Means to California," "Harnessing Sierra Streams," "A Modern Power Plant in California," "Electric Power for the Farmer," "Electricity for Irrigation," "Cheap Power an Invitation to the Manufacturers," and "Electrical Power in Mining."

A New Pipe and Conduit Bender.

The Chicago Pneumatic Tool Company, Fisher Building, Chicago, Ill., has built a simple pipe-bending machine that may be used for a great variety of work. The apparatus is entirely self-contained and will bend electric conduits without crushing the pipe or injuring the protective coating.



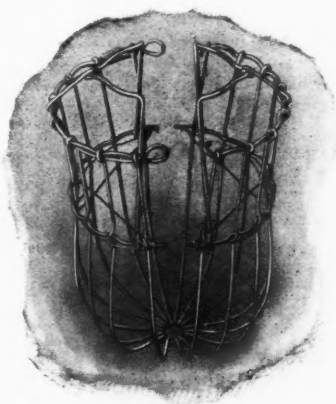
PIPE AND CONDUIT BENDER.

The apparatus is designated as the "Chicago" pipe-bending machine, and it requires the services of an ordinary helper only, who can, with the aid of this machine, bend pipe to any desired complex curvature in a very short time. The machine is operated by a hand-wheel which carries a pinion. The latter engaging a quadrant-gear operates the bending quadrant. One end of the pipe which is to be bent is held in position by a U-shaped clip, while a pin or roller in the platen engages the other end. The placing of the pin or roller in the different holes governs the curvature obtained.

Being light in weight, it is readily carried from shop to job, or *vice versa,* and can be secured to any column, stanchion or any available support in a few minutes, or a suitable stand can be furnished, as shown. Piping of steel, iron, brass, copper or other materials up to two inches in diameter can be bent cold. It is also well adapted for the use of special dies that can be readily attached for bending light angles, flats or tee-bars to any desired radius as easily as bending pipe. One can, without assistance, bend a piece of two-inch pipe to an S-bend in three minutes. The cost of repairs, where it has been used ten hours per day in shipyards, railroad shops and other places, has been very slight.

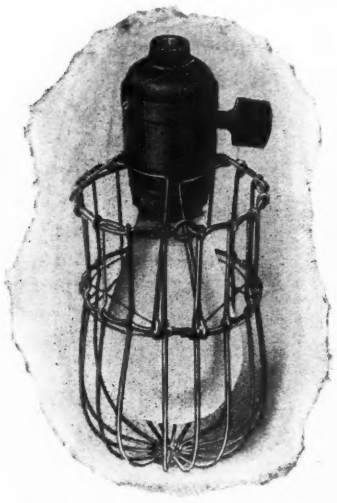
A New Form of Wire Lamp Guard.

The accompanying illustrations show a simple form of incandescent electric lamp guard made by the P. R. Wagor Manufacturing Company, Springfield, Mass. The lamp guards are very easily sprung apart and on to the lamp, and manipulated so as to grip the socket very firmly. While they are put on very easily, it is difficult to shake them off or throw them



WIRE LAMP GUARD.

to one side through accident. The wires are small, are near to each other and fit snugly up to the incandescent bulb.



WIRE LAMP, GUARD ON LAMP.

These conditions produce adequate protection for the lamp bulb, and at the same time interfere very slightly with the distribution of the light.

Semi-Annual Report of the Chicago Pneumatic Tool Company.

The semi-annual report of the president to the shareholders of the Chicago Pneumatic Tool Company, of New Jersey, has been made public. This shows a very healthy condition of affairs in this well-known company. The statement of profits for the half year ending June 30, 1905, is appended herewith:

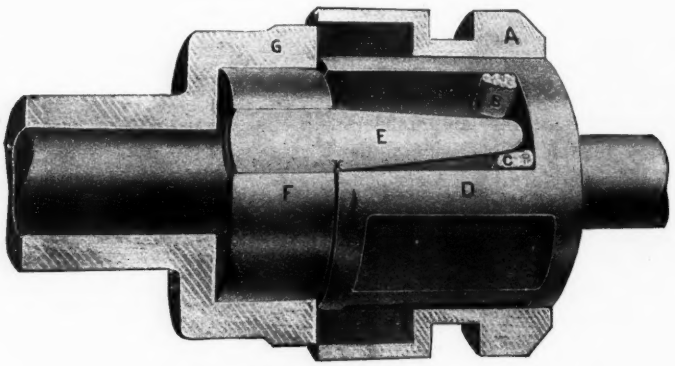
Profits for the half year		$413,941.54
Less—Depreciation of buildings, plant and machinery, including repairs and renewals of buildings and plant	$52,905.02	
Less—Written off for experimenting and perfecting new lines of tools	4,800.00	57,705.02
		$356,236.52
Less—Bond interest for the half year	$57,500.00	
Less—Sinking fund reserve	25,000.00	82,500.00
Profit available for dividend		$273,736.52
Less—Quarterly dividend No. 9 (1½)	$61,137.83	
Quarterly dividend No. 10 (1½)	61,137.83	122,275.66
Balance carried to surplus		$151,460 86
SURPLUS ACCOUNT		
Surplus brought from 1904	$254,030.82	
Less—Appropriation on account of development work and written off	28,593.51	$225,437.31
Surplus for the half year ending June 30, 1905		151,460.86
Surplus carried forward		$376,898.17

An Automatic Clutch.

The Automatic Clutch Company, Akron, Ohio, has designed and placed on the market an automatic clutch which it states is an ideal device for the service it is intended to perform.

A clutch, no matter of what type, is designed to take up the load and transmit power, subject to the will of the operator. The load should be accelerated from rest to full speed uniformly and it should be possible to disengage the clutch and drop the clutch with facility.

The accompanying illustration shows the mechanical details of the Automatic Clutch Company's device. As illustrated, the clutch is in the disengaged or "off" position. A is the operating sleeve which carries the pins B and C, shown in section, which fit between the faces of the cavity in the keyed member D. Loosely placed between the pins B and C is a lever E, which extends between the ends of the expansion ring F, which is surrounded by the cup or loose member G. Now if the keyed member D be rotating in the direction indicated by the arrow, the ring is freely revolved by the lever E, which is driven at point *x*, as pin C is free of the lever; and pin B operates on the lever only when the member D is revolving in the opposite direction.



AUTOMATIC CLUTCH.

When the clutch is engaged the sleeve A is moved to the left, and pin C gradually relieves the bearing point *x* on the lever, and the member D drives the ring by the lever through the pin C. This causes the lever E to expand the ring F within the cup G, with such pressure that the friction exceeds the force on the lever, therefore the greater the load the lighter the grip.

Annual Meeting of the National Battery Company.

The annual meeting of the stockholders of the National Battery Company was held August 4, at the general offices of the company in Buffalo, N. Y. The old board of directors was continued unchanged, and the following officers of the company were elected:

Mr. John R. H. Richmond, who was formerly treasurer, was elected president of the company.

Mr. James McNaughtan, formerly vice-president, was continued in the same office.

Mr. Ralph Kimberly, formerly secretary, was appointed to fill the offices of both secretary and treasurer, the latter office being the one formerly occupied by Mr. Richmond.

Mr. Richmond and several associates have taken a large block of the increased capital stock, which will be used in the further extension of the business.

Mr. R. L. Coleman, formerly president of the company, was elected chairman of the board of directors, and he still retains his large interest in the company.

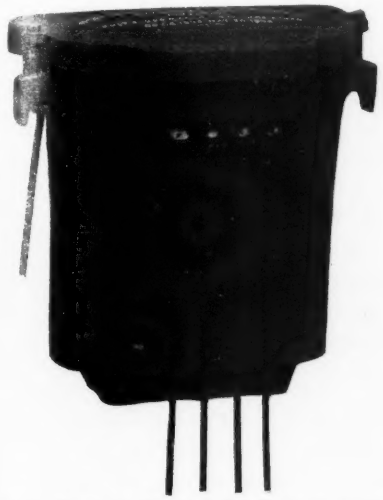
Mr. James McNaughtan, under whose management the company has been brought to its present position of strength and activity, was reappointed general manager of the company.

The company ranks high in this country in the electric storage battery business. The results accomplished during the past year have encouraged the stockholders of the company and extensive plans for further development have been made.

The company has a fine organization, the sales manager being both an electrical and mechanical engineer, with an extended commercial experience; the factory manager being a thoroughly trained technical man, who has been connected with this company from its inception. Other departments of note are the engineering, construction and publicity departments, all of which are managed by men carefully selected for their ability and training in their particular line of work.

Type C Transformers.

The Westinghouse Electric and Manufacturing Company has placed upon the market a new line of core type transformers in addition to the large assortment of transformer apparatus regularly made, with which users of electrical appliances are familiar. These transformers



FRONT VIEW OF TYPE "C" TRANSFORMER.

will be known as type C, and are simply an addition to the many standard forms, so that Westinghouse transformers of any desired form and construction may be obtained to meet the varying demands of present-day light and power service.

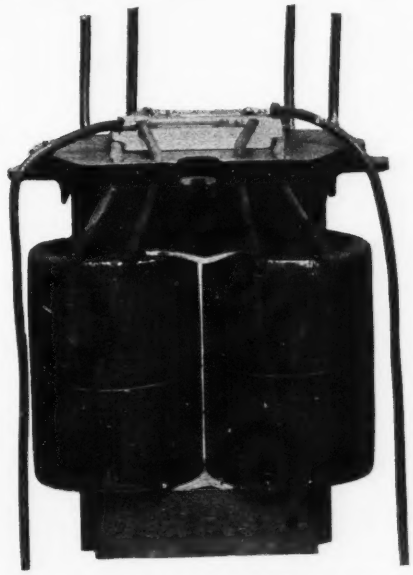
The type C transformers have operating characteristics closely approximating

TYPE "C" TRANSFORMER, SHOWING METHOD OF SUSPENSION.

those of Westinghouse type O. D. transformers; their regulation is extremely close, the efficiency high, operating temperature low, and a high grade of insulation ensures long life under severe conditions. They are intended for general distribution service on sixty-cycle circuits operating nominally at 1,050 and 2,100 volts, although they will operate successfully on voltages up to 1,200 and 2,400. They are manufactured in sizes from 0.6 to fifty kilowatts all wound for the same primary voltages, but divided into classes according to the voltages of the secondary. Class 200 may be connected for either 105 or 210 volts, and class 400 for 210 or 420 volts.

The transformer is enclosed in a cast-iron case with felt gaskets under the lid, so as to make the transformer absolutely weatherproof. For sizes above twenty kilowatts the case is corrugated to increase the radiating surface, but in the smaller sizes a smooth case has surface sufficient to radiate the heat generated. Hanger irons are provided by which any transformer up to and including the thirty kilowatts may be mounted on a pole.

The core of a type C transformer is built up of carefully annealed steel punch-



INTERIOR VIEW OF TYPE "C" TRANSFORMER.

ings of cruciform shape, and is practically non-aging. The primary and secondary coils are placed on the long sides of the core, the laminations of which are clamped together at top and bottom by suitable end frames. The low-tension winding is composed of one coil per leg, each coil having two sections so connected that the inner section of one leg is in series with the outer section of the other leg. This arrangement results in a secondary winding of two exactly similar parts both as to resistance and reactance, and ensures equal loading of each primary coil irrespective of the method of loading the secondary. A balanced voltage is thus maintained on the two sides of a three-wire distributing system irrespective of the load. The high-tension winding is divided into two coils per leg to reduce the voltage between layers of the winding to a low value.

The core-type construction allows the use of a circular coil, which has many advantages. All insulating parts between layers of the winding and between high and low-tension coils are cylindrical in form, eliminating sharp corners which are harmful to insulating material. The windings are so disposed and oil ducts so provided that a free circulation of oil between coils and core is obtained, ensuring ready dissipation of the heat and preventing deterioration of the insulation. Very careful attention has been paid to the insulation and liberal allowance made to ensure a high factor of safety.

The design throughout has been worked out with the greatest care, and a line of transformers has been produced which can be relied upon for economical operation, durability and continuity of service. Their regulation and efficiency are as perfect as can be secured without detriment to other desirable features. All coils are wound to exact dimensions and all insulation is cut to gauge, so that the corresponding parts of all transformers of the same capacity are interchangeable.

Indiana Traction Lines Almost Double in Value During Past Year.

That the property of the street car and interurban railway companies has almost doubled in value in the last year is shown by the assessments made against these companies by the Indiana state board of tax commissioners, a report of which was given out at the close of its first session recently. The total assessed value of these lines is $26,387,366 as compared with an assessed valuation of $13,702,394 last year.

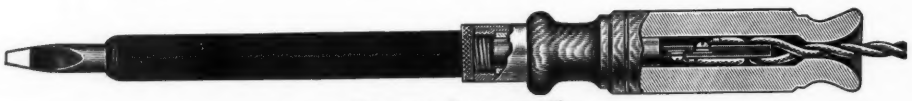
A close examination of the assessment schedule shows that while the aggregate assessment is much greater, there is no marked general increase in the individual assessment per mile, the remarkable increase being due both to the extension or increased mileage of old roads and the building of new roads.

The assessment of steam road property shows a slight general increase over last year, the total reaching $178,000,000 against $165,863,367 for last year. There was no general increase or decrease in this assessment, the individual roads having increased their mileage for the most part.

There was an increase in the assessment of express companies due to some extent to business being done over the interurban lines.

The "Vulcan" Electric Soldering-Tool.

Of the latter-day adaptations of electricity to the heating of working apparatus, one of the most satisfactory and practicable is the electric soldering-tool. In this apparatus the heat is concentrated



ELECTRIC SOLDERING-TOOL

in the tip of the soldering copper, minimizing radiation from all other parts of the tool and confining the heating to the copper continuously, eliminating also gaseous fumes and waste heat.

The "Vulcan" electric soldering-tool has been designed by L. P. Brown & Company, 71 West Jackson Boulevard, Chicago, Ill., after a full year of careful experimentation and study to bring it to its present state of practical usefulness. The tool heats in three minutes, consumes the least possible energy consistent with ample heat at the tip, is light but rigid in construction, has a most satisfactory arrangement of handle and terminals, and the maker guarantees is first class in every respect.

The maker of this tool also declares that it is probably the opinion of most manufacturers that electrically heated soldering-tools would be a great acquisition if they could be made to do the work satisfactorily and with economy, but most of these manufacturers are not educated to the fact that the electric soldering-tool is superior in every way to the gas-heated soldering copper, that it will maintain uniform heat for hours at a time without losing its tinned surface and that the efficiency with which the energy is applied results in the expense of the electric heat being less than the average cost of operating gas furnaces.

The tools are made for 100, 104, 110, 115, 120, 200, 210, 220, 230 volts, and are furnished with renewable tips.

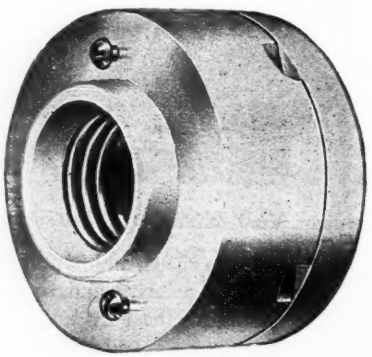
"Newcode" Weatherproof Socket and Sign Receptacle.

Stanley & Patterson, Incorporated, 40 Cortlandt street, New York city, has added to its line of "Newcode" receptacles, the weatherproof socket, No. 1010, and sign receptacle, No. 1020, shown in the accompanying illustration.

"Newcode" weatherproof sockets No. 1010 permit connections to main circuits by simply skinning the wires where necessary to slip under contact screws of socket. The two-circuit wires run straight through all the sockets in the line. There are no joints necessary anywhere. After the binding-screw is turned down on the bared wire, the job is practically done. All that remains is to put on a porcelain cap. Through this porcelain cap is a lateral hole, permitting the suspension of the whole row of sockets from a small steel strand. This makes possible a regular festoon of lamps with no weight on the socket connections.

"NEWCODE" WEATHERPROOF RECEPTACLE.

"Newcode" receptacles No. 1020 are quickly attached to the metal work of the sign letter by two machine screws,



"NEWCODE" SIGN RECEPTACLE.

entering from the face of the letter. They require no soldering, taping or painting. All that is necessary is to turn down the binding-screws on the wires, put on the porcelain cap, and the sign letter is ready for current.

Advertising Engineers.

Mr. Halbert P. Gillette, formerly associate editor of *Engineering News,* and Mr. Geo. H. Gibson, formerly manager of publicity for the International Steam Pump Company, manager of the advertising department of the B. F. Sturtevant Company, and editor of the Westinghouse Companies' publishing department, have formed a partnership as "advertising engineers," under the name of Geo. H. Gibson Company, with offices in the Park Row Building, New York city. They undertake to conduct a firm's advertising in the same manner as would a department in the firm's own offices, and are not advertising agents in the usual sense of the term, as they receive no commissions, rendering only service and leaving the actual purchasing of space and printed matter in the client's hands.

Charles S. Bradley & Sons.

A new firm of consulting engineers devoted to electrical engineering, electrochemistry and general experting, has been formed by Charles S. Bradley and his two sons, Alonzo B. Bradley and Walter E. F. Bradley, both of whom graduated from Columbia University with the degree of electrical engineer. Bradley & Sons will have their offices at 41 Park Row.

Mr. Charles S. Bradley is quite widely and appreciatively known in the electrical field. He was associated with the Edison Illuminating Company in 1881, and afterward with the Fort Wayne, Thomson-Houston and General Electric companies. He is to be credited with a number of important inventions in polyphase machinery, electrolytic fusion processes, fuses, rotary furnaces for the production of calcium carbide and other important work.

Alonzo B. Bradley, since his graduation at Columbia in 1903, has been associated with the General Electric Company, and was engaged as engineer to assist in bringing to this country a French electrochemical process which is now established at Niagara Falls.

Walter E. F. Bradley, who graduated from Columbia in 1905 as an electrical engineer, was quite prominent at the university, being manager of the university crew, president of the Columbia University Electrical Engineering Society and president of the senior class School of Mines.

The new firm is prepared to engineer and supervise the construction of isolated electric lighting and power plants, and gas engine, electrochemical, electric lighting and electric railway plants, and is particularly well equipped to pass upon the commercial value and practicability of inventions. Electrical, mechanical and chemical devices and processes will be examined with a view of overcoming existing difficulties, or to meet new conditions. The firm will undoubtedly occupy a recognized position of character and excellence from the start.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

CONTRACT FOR POWER PLANT—The board of directors of the Winchester & Washington City Electric Railway Company has opened bids for the construction of the dam, power-house, and raceway along the Shenandoah river near Millville, Jefferson County, W. Va., which is to furnish power for electricity for Winchester and other towns in this section. E. Purcel & Company, of Harrisonburg, Va., being the lowest bidders, were awarded the contract for $56,322.50. Eight other firms competed.

IMPROVEMENTS TO PLANT OF THE DENVER GAS AND ELECTRIC COMPANY—Improvements to cost $150,000, which would increase the present lighting capacity of the Denver Gas and Electric Company about twenty-five per cent, as well as give it one of the most up-to-date plants in the country, are now under way at its main power-house in Denver. Announcements of the improvements which have become imperative have recently been made by General Manager Frank M. Frueauff. A brick addition to the present plant, two stories high and 132 feet square, will be built. It is announced that a steam turbine of 3,000-kilowatt capacity will be installed.

POWER PLANT AT AROOSTOOK FALLS—The work of surveying for the large plant to be built at Aroostook Falls to develop the water power of the Aroostook river, has begun under the direction of the Maine & New Brunswick Power Company. The estimated horse-power at the falls is 8,000 and the river has a drop of seventy-two feet in three-quarters of a mile. Electric power will be furnished for a greater part of Aroostook County and the western part of New Brunswick, including Fort Fairfield, Houlton, Presque Isle, Caribou and Limestone in Maine, and Andover and Perth and New Brunswick. The town of Houlton, fifty miles south, has already voted to take power for street lighting.

MEXICAN POWER PLANTS—The Los Jeronimos waterfall, situated in the Pedreñas valley, in the state of Guerrero, Mexico, has been sold to a Belgian company for the sum of $300,000 gold. This fall is 120 metres in height. The company that bought it intends to install an electric power plant. Allende, Mexico, is to have electric lights. The Platt Iron Works, of Dayton, Ohio, has closed a contract with the local company which will construct the plant for a large turbine and the electrical machinery which will be required to equip the plant. The Allende company was promoted and organized by Enrique Guerra and is composed of the following: Pedro Gonzalez, Jr., Jose Gonzalez, Jase Angel Garza, Poncviano Romero and W. C. Cadena.

NEW OREGON POWER PLANT—Work on the Olive lake power plant at Sumpter, Ore., will begin shortly. At a recent meeting of the Red Boy Mining Company the water rights, ditches and fumes owned by it were sold to a new company for a consideration of $50,000, this amount to be paid in electric power as the Red Boy company may need. The power company will be a separate and distinct organization with an authorized capitalization of $200,000 and will immediately issue $100,000 bonds to complete the big dam, pipe line and installation of the necessary machinery to generate 1,500 horse-power, of which 600 will be reserved for the mine and the remainder will be sold to companies operating in that section. It is proposed to dispose of the steam sinking plant and replace it with a modern electrical equipment.

ELECTRICITY ON SPANISH RAILWAYS—The Central Railway and Tramways Company, of Spain, which holds the concession for the Barcelona-Badalona and Masnou tramways, recently applied to the government for permission to permanently retain the wooden poles, which they were authorized to erect temporarily for the tramway trolley system, but permission has been refused, and the company has been ordered to substitute steel poles as originally specified. The Malaga Tramway Company has asked permission to employ electric traction on the Huelin Riego-Torrijos line. An interurban electric tramway system for Barcelona has been approved, and an electric tramway from the Tonero line to the cemetery at Sarragossa. The substitution of electric traction for the present system on the Murcia Palmar Tramways has also been authorized.

EXTENSIVE ELECTRIC ROADS IN THE ADIRONDACK MOUNTAINS—Work will soon be begun on an extensive system of electric railways covering the southeastern portion of the Adirondack region, connecting Lake Champlain and Lake George with Schroon Lake, Lake Placid and many intermediate points. The company which will build the road was recently incorporated under the name of the Ticonderoga Union Terminal Railroad Company and is promoted by a number of prominent New York, Philadelphia and Chicago capitalists. The proposed lines of railway are as follows: connecting with the Rutland Railroad division of the New York Central & Hudson River Railroad at Addison Junction and running to and through the village of Ticonderoga to the mines of the International Mineral Company, making connections with the Delaware & Hudson Railroad and also maintaining a system of street railways in the village of Ticonderoga to Lake George, with a spur to old Fort Ticonderoga, with the view of developing 600 acres of land owned by the company into a national park; also from Ticonderoga to Schroon Lake and to Lake Placid; and also from Schroon Lake to Lake George at Hague and to Lake George post office at the southern end of the lake. It is proposed also to build a line from Elizabethown to Lake Placid. Independent boat lines will be maintained on Lake George and Lake Champlain. The company intends to erect dams for the development of power to operate the roads in the vicinity of Ticonderoga. At the present time the company has options on all the electric power plants along its proposed routes.

RIGHT OF WAY FOR MINNEAPOLIS GENERAL ELECTRIC—Minneapolis General Electric Company has secured the right of way over which the 50,000-volt current will be brought from Taylor's Falls across the state. A sixty-foot right of way forty-one miles in length and running almost direct from the power-house at Taylor's Falls to the site of a new Minneapolis transforming station has been purchased outright. The work of building the transmission line has already been carried some distance toward the city. Fourteen miles of poles are already in place and ready for equipment. Oregon poles will be used much of the distance, but at points where there is special strain on account of open spaces and long spans steel towers will take the place of the wooden poles. The wire used is heavy copper about a half-inch in diameter. The insulators are of porcelain and weigh twenty-two pounds each. A three-phase system of transmission will be used. The current will be generated at the plant now under construction at the falls at 2,300 volts. It will be boosted to 50,000 volts for transmission. At the transforming station to be erected on the site just purchased, it will be reduced to 13,000 volts and sent out for use. Eventually, another line will be run over the right of way for the power to be used for St. Paul. At first but one line capable of producing 25,000 horse-power will be constructed and will be used exclusively for Minneapolis. This will greatly increase the amount of power available in the city and a reduction in cost of electricity to the consumer is contemplated. Work on the dams and other construction at Taylor's Falls is being pushed with the hope of completing it before frost sets in and stops all concrete construction. The wet weather and high water have interfered considerably.

NEW MANUFACTURING COMPANY.

SPOKANE, WASH.—The William E. Chase Engineering Company has been incorporated by William E. Chase and F. E. Chase, with a capital of $10,000, to carry on a general electric engineering business.

ELECTRIC LIGHTING.

NIAGARA FALLS, N. Y.—A contract has been awarded to the River City Construction Company for the building of the trolley line of the Electric City Railway Company.

ELGIN, ILL.—The municipal lighting plant of the city of Elgin has been turned over to a private corporation, in accordance with a deal entered into some months ago.

HARRISBURG, PA.—The Harrisburg, Pa., school district will equip an addition to the Technical High School and will install an engine and generator among other equipment.

STERLING, ILL.—The road commissioners of Sterling township have extended the franchise of the Rock River Traction Company from January 1, 1906, to November 1, 1906.

POSEYVILLE, IND.—Poseyville is to have a waterworks system and an electric light plant. A company with $10,000 capital, all of which is subscribed, has been organized and will build the plant.

TOPEKA, KAN.—L. E. Myers, president of the Topeka Railway Company, announces that he and his associates have bought a controlling interest in the Edison Electric Illuminating Company.

SIOUX CITY, IOWA—The Sioux City Service Company, incorporated under the laws of New Jersey, with a capital of $250,000, is to construct and operate the Sioux City lighting and heating plant.

MAYSVILLE, KY.—Dr. W. Godfrey Hunter and associates have secured control of the stock of the Somerset Water Company, valued at $150,000. It is the purpose of the new company to erect a light and power plant.

FORT GAINES, GA.—The city of Fort Gaines has granted to the Interstate Waterworks and Construction Company, of Washington, D. C., a fifty-year franchise for the construction of a waterworks and electric lighting plant.

TORONTO, ONT.—The city of Windsor has decided to build an entirely new and modern lighting plant, and as soon as it is completed application will be made for legislation permitting the city to engage in commercial lighting.

LIMA, N. Y.—Charles B. Hill, as receiver of the Lima-Honeoye Electric Light and Railroad Company, has sold all the accounts, franchises, property, rights of way and assets of said company to William J. Connors, of Buffalo, for $16,000.

CHICAGO, ILL.—The Commonwealth Electric Company is about to begin the construction of another section of its power plant at Fisk and West Twenty-second streets. The building will cover an area of 85 by 260 feet and cost approximately $450,000.

WETHERSFIELD, MICH.—The Kewanee Light and Power Company has been given a franchise by the Wethersfield village board to extend its mains and electric lighting system throughout the town. The franchise runs for twenty-five years.

CINCINNATI, OHIO—The directors of the Gas and Electric Company have authorized the purchase of a new system of electric batteries for the basement of the company's building at Fourth and Plum streets. This new equipment will cost $250,000.

ROCKVILLE, CT.—The management of the Rockville Gas and Electric Company announces that it will immediately commence extensive improvements to the plant in Rockville. The plant is owned by the Connecticut Railway and Lighting Company.

OAKLAND, ORE.—The city of Oakland has made a five-year contract with the Calapooia Investment Company for power to operate the electric light system. The new power plant on the W. P. Sedge farm will be in operation on or before November 1.

WATERVILLE, ME.—The work of building the dam for the Messalonskee Electric Company at Rice's Rips has been begun. The site of the dam is to be about a mile and one-half below the town of Oakland. In order to construct the dam, a large coffer dam will be built.

HARRISBURG, PA.—Notice of the merger of fifteen electric light and gas companies in Luzerne County, Pa., into one company, with a capital of $1,000,000, has been filed in the state department, with the approval of Governor Pennypacker. The officers of the new concern are: C. H. Geist, Philadelphia, president; H. W. Noble, Detroit, vice-president; C. B. Kelsey, Grand Rapids, Mich., secretary and treasurer.

YORK, PA.—The plant of the Delta Electric Light Company, located along Muddy creek, has been purchased by the York Furnace, Pequa & Lancaster trolley company. The purchase was made for the purpose of furnishing power for the proposed new extension into York County.

NASHUA, N. H.—At the annual meeting of the Nashua Light, Heat and Power Company the company voted to increase its capital stock $100,000, making it $600,000. The following directors were elected: F. W. Esterbrook, F. E. Anderson, James H. Tolles, George E. Anderson and Elbert Wheeler.

PAINESVILLE, OHIO—The eighty days' option which outside parties had secured on three-fourths of the stock of the Commercial Electric Light Company has expired. It is understood that the parties have given up the idea of securing control of the plant as the price asked was too high.

EUSLEY, ALA.—The citizens of Eusley, Ala., have voted to erect a municipal lighting plant. A bond issue will be authorized. There are now but ten arc lights in the streets, which cost the city between $800 and $900 per year. At least fifty such lights are necessary to properly light the streets.

OTTAWA, QUE.—The city of Ottawa and the Consumers' Company have reached an agreement by which the city pays the latter the sum of $200,000 for its plant, the company, however, to hand over to the city only $3,000 worth of the $10,000 stock on hand, this making the price equivalent to $207,000.

CHESTER, PA.—The new track along the Philadelphia, Baltimore & Washington Railroad, known as No. 1, has been put into use for passenger service between Glenolden and Darby, taking in Folcroft, Sharon Hill and Academy stations. The four-track system is now completed between Chester and Darby.

PONTIAC, MICH.—The Clinton River Power Company has been organized with a capital stock of $75,000, of which $40,000 is paid in. The company will generate electricity at Amy by means of water power and sell it in Pontiac for commercial purposes. The plans contemplate the ultimate erection of three dams.

INDIANAPOLIS, IND.—Judge Carter, of the Superior Court, has ordered that the property of the Home Heating and Lighting Company, which has been in the hands of a receiver for a year, be turned over to the People's Light and Heat Company, according to a contract entered into recently by the latter and the board of public works.

BELOIT, WIS.—The common council has rescinded the ten-year contract with the Beloit Electric Company for lighting the streets of the city. This was done because of the failure of the company to carry out extensions and improvements as agreed upon in the contract. The company will continue to light the streets from month to month at the present rates.

TURNERS FALLS, MASS.—The Franklin Electric Light Company at its anual meeting elected these officers: president, J. F. Bartlett; treasurer, W. C. D. Thomas; secretary, E. I. Cassidy; directors, the above and W. D. Russell, Porter Farwell, C. W. Schuler and C. W. Hazelton. The company will at once prepare for a considerable extension of its business.

SANFORD, ME.—The Alfred Light and Power Company, which is controlled by the Atlantic Shore Line, has taken over the Linscott and Ester water privileges which were purchased of Bodwell Brothers some time ago. In developing these privileges, they will make one privilege at the Ester dam and that will give them a water power capable of developing 800 horse-power.

SYRACUSE, N. Y.—The entire system of the Syracuse Rapid Transit Company will be overhauled this summer so far as possible. Nearly 200 extra men are at work and will be employed until late in the fall. The sum of $200,000 will be expended, making the work which will be done this summer the most important that the company has ever taken up during a single season.

LARAMIE, WYO.—The city council has granted a twenty-year electric light franchise to Alfred E. Kalter, of Indianapolis, and

entered into a ten-year contract for lighting the streets and public buildings of the city, the price being fixed at $10 per month for 2,000-candle-power arc lamps, $6 for 1,200-candle-power arc lamps and ninety cents a month for sixteen-candle-power incandescent lamps.

WHEELING, W. VA.—A large amount of stock in the Ohio Valley Electric Light and Power Company, which was recently incorporated from the union of the Benwood & McMechen Electric Light Company and the Home Electric Light Company, of McMechen, has changed hands. It is understood that William and August Schad and Michael Deegan have sold out and that the purchasers are backed by William Snider, president of the company.

NORRISTOWN, PA.—The Montgomery Traction Company, which recently purchased the Norristown & Lansdale trolley road, at a meeting decided to make a number of improvements to the road, one of which is a thirty-minute service instead of an hourly one. The following directors were elected: T. M. Dodson, S. B. Linderman and Francis Weiss, Bethlehem; T. A. H. Hay, Easton; M. P. McGrath, Worcester, Mass., and Robert M. Petty, Washington. W. O. Hay, of Easton, was elected president, and George A. Reed, of Bethlehem, secretary and treasurer.

LIMA, OHIO—General Manager Bendure has announced the leasing of the Lima Electric Railway and Light Company's properties to the Lima & Toledo Traction Company, of which W. Kelsey Schoepf, the western representative of the Widener-Elkins Syndicate, is president. The lease is effective July 1. Further announcement was made that the Lima-Toledo line would be completed north as far as Leipsic by late fall, and that cars of the new holding company have already been ordered. The contract for the new line has been let to the Buckeye Construction Company.

MONTGOMERY, ALA.—The Pea River Power Company, with headquarters at Elba, Ala., has filed notice of its incorporation with the secretary of state. The capital stock is stated at $100,000. This company proposes not only to light the city of Elba with electricity, but to supply heat and power and electricity for all commercial and domestic purposes. The incorporators are Charles Henderson, H. D. Boyd, J. M. Garrett, B. W. Page, Y. W. Rainer and W. B. Perdue. The headquarters of the company will be in Elba, but the plant will be some distance from the city.

TOLEDO, OHIO—A merger of the Toledo Gas Light and Coke Company and the Toledo Heating and Lighting Company has been effected. A new corporation, the Toledo Gas, Electric and Heating Company, takes over the two plants and will operate them. The combining of these two companies has been in progress more than a year. The purchasing syndicate, mainly local capitalists, is composed of Thomas H. Tracy, James S. Bailey, Jr., J. K. Secor, W. F. Robinson, Lawrence B. Pierce, of St. Louis, and a Cincinnati party. The capital stock of the new corporation is $2,500,000.

NEW YORK, N. Y.—The Glen Cove Railroad Company, which operates a short line in that village, and which is believed to be controlled by the Long Island Railroad Company, has announced that it proposes to extend its line through several streets in Glen Cove, and will also purchase a right of way, from private owners, for a trolley line to Sea Cliff, which is taken as an indication that the line will eventually reach Mineola and connect with the present system of the New York & Long Island Traction Company, now jointly owned by the Long Island Railroad Company and the Interborough Rapid Transit Company, of New York.

NATCHEZ, MISS.—The board of aldermen of Lake Providence has granted to the Lake Providence & Gouldsboro Railway and Power Company, chartered on May 31, last, a franchise for twenty-five years for the purpose of building, equipping and operating an electric railway from Lake Providence to the Gouldsboro suburb, and to Lake Providence Landing. The line is to be three miles long, and to be extended later. The officers of the company are: Joseph L. Fischer, president; W. E. Dunn, vice-president; Edward J. Hamley, secretary and treasurer; Victor M. Purdy, W. T. Tyler, Joseph E. Ransdell, directors, and A. B. Sanders, manager.

READING, PA.—Application has been made to Governor Pennypacker for a charter for the incorporation of a new company to be known as the Cumru Township Electric Light, Heat and Power Company. The incorporators named in the application are Wm. F. Krick, Henry H. Yost and George W. Wagner. The capital is $5,000, divided into $25 shares. Mr. Krick is the president. The new company intends supplying light and power to residents of Shillington, Edison and that section. Current will be generated at the plant of the Sinking Spring Electric Light Company and feed wires will be erected to Shillington and vicinity. Work will begin as soon as the charter is granted.

KNOXVILLE, TENN.—At the annual meeting of the stockholders of the Knoxville Traction and Knoxville Electric Light and Power companies the following officers were elected for the Knoxville Traction Company: president and general manager, Charles H. Harvey; vice-president, W. S. Shields; secretary, Leon Fender; treasurer, H. T. Bunn. Directors: Charles H. Harvey, W. S. Shields, A. H. Ford, G. W. Bacon, G. H. Davis, J. K. Newman, E. E. McMillan. The officers elected for the Knoxville Electric Light and Power Company are as follows: president, Charles H. Harvey; vice-president, G. H. Davis; treasurer, H. T. Bunn; secretary, Leon Fender. The same board of directors was elected.

SALT LAKE CITY, UTAH—The Salt Lake county commissioners have granted to Emil J. Raddatz a franchise to build and operate an electric transmission system from Big and Little Cottonwood cañons to Bingham Junction and Sandy, the line to be completed by next January, and the cost of the construction to be $500,000. The president of the company is J. J. Chambers; vice-president, W. J. Craig; secretary, E. J. Brake; treasurer, C. O. Ellingwood; general counsel, Bismark Snyder. Samuel Levy, Gideon Snyder and Mr. Raddatz, with the above officials, form the directorate. The capital stock is $1,500,000, and the company will operate wholly in the county, outside of the city, with the intention of extending operations to Bingham and Park City.

GREENFIELD, CT.—A bargain has practically been struck between the Connecticut Valley Street Railway Company on one hand and the Greenfield Electric Light and Power Company on the other, for power to operate the entire system, so far as may be needed beyond the power furnished by the plant at Millers Falls, which is to be retained. No contract has been signed as yet, but it is expected that one will be very soon. Rights have been secured for a pole line from Greenfield to Hadley, a distance of twenty-three miles. At Hadley a substation, in an independent building, will be erected. High-tension power by the three-phase system will be transmitted. To change over to the new system an expenditure of $50,000 is necessary. To care for this, stock and bonds will probably be issued.

SHERMAN, TEX.—At a meeting of stockholders of the interurban railway from Sherman to Gainesville *via* Whitesboro, a board of directors for the first year was elected as follows: H. A. Hassinger, New Orleans; John King, Gainesville; Judge Henry L. Lazarus, New Orleans; H. G. Stinnett, Sherman; W. R. Brents, Sherman; J. M. Buchanan, Whitesboro; S. B. Cowell, Whitesboro; Henry Bier, Gainesville; Geo. E. N. Ball, Gainesville; O. F. Hailey, Gainesville. These directors in turn held a meeting and elected officers as follows: G. A. Hassinger, president and general manager; John King, vice-president and assistant general manager; Henry Bier, secretary and treasurer. The company, which will be chartered as the Gainesville, Whitesboro & Sherman Railway Company, will be capitalized at $500,000.

TRENTON, N. J.—A certificate of reorganization of the Princeton Lighting Company has been filed. The new corporation is named Princeton Light, Heat and Power Company and its authorized capital stock is $250,000, divided into 5,000 shares of the par value of $50. The office will be in Princeton, N. J., and Richard Stockton will be the agent in charge. Herman Dowd, of Orange, the purchaser of the plant, is president and also a director of the new company. The other directors are George Whitefield Betts, Jr., Englewood; Bayard Stockton, Princeton, and J. H. McNeal, Philadelphia. The Princeton Lighting Company was formed February 27, 1903, by the merging of the Hopewell Light, Heat and Power Company, the Princeton Electric Works and the Princeton Gas Light Company. It did not prove a financial success and Richard Stockton was appointed receiver to wind up its affairs. Recently the plant was sold under court of chancery proceedings and Dowd was the purchaser. The new company is formed to continue the business.

NEW INCORPORATIONS.

ENTRIKEN, PA.—Woodcock Valley Telephone Company. $5,000.

BELLEVUE, IOWA—Bellevue Telephone Company. Capital changed to $5,000.

MAYSVILLE, KY.—Maysville, Carlisle, Millersburg & Paris Traction Company. $30,000.

GALESBURG, ILL.—The Galesburg Union Telephone Company. Capital increased from $150,000 to $250,000.

NEW BRITAIN, CT.—The Farmington Valley Telephone Company. Absorbed the Sharon Telephone Company.

KANKAKEE, ILL.—Kankakee Electric Railroad Company, Kankakee. Capital increased from $60,000 to $100,000.

AUGUSTA, ME.—Southern Power and Improvement Company. $10,000. President and treasurer, I. L. Fairbanks, Augusta.

CAMP HILL, PA.—The Camp Hill Illuminating Company. $5,000. Directors: Naudain Hamilton, George Nauman and Robert C. Neil, Jr.

DENVER, COL.—Citizens' Electric Power and Manufacturing Company. $50,000. Incorporators: G. H. Sethman, C. M. Smith, G. W. Gillespie.

NEW YORK, N. Y.—The Clark Electric Manufacturing Company. $100,000. Directors: G. W. Kyburg, T. J. Conry and O. P. Nevin, New York.

ROODHOUSE, ILL.—Roodhouse Light, Heat and Power Company. $30,000. Incorporators: E. C. Kreider, Sr., W. J. Kreider, Nellie C. Kreider.

JASONVILLE, IND.—The Jasonville Electric Company. $9,000. To operate lighting plant. Incorporators: H. L. Hyatt, J. H. Parsons, H. L. Hannah.

EVANSVILLE, IND.—Evansville & Mt. Vernon Electric Railway, Evansville, Ind. Capital stock increased from $10,000 to $300,000. Fred W. Reitz, secretary.

CHAGRIN FALLS, OHIO—The Home Telephone Company. $10,000. Incorporators: T. F. Ryan, W. R. Nutt, J. T. Daniels, R. J. Brown and James Hiven.

MONTPELIER, VT.—The St. Johnsburg Electric Company. To purchase and sell water power, real and personal property, and to do a general electrical business.

READING, PA.—Reading Illuminating Company. $100,000. Directors: Daniel J. Driscoll, Reading; Gustavus Ulbrecht, Brooklyn; Ralph W. Gifford, New York.

JERSEY CITY, N. J.—Merchants and Miners' Telephone and Telegraph Company. $500,000. Incorporators: Sidney R. Perry, Joseph Gales, Jr., James L. Stewart.

CHICAGO, ILL.—Illinois & Wisconsin Railway, Chicago, $10,000. Incorporators: G. M. Stevens, Henry Lutzenkirchen, G. W. Bryson, H. K. Crafts, C. E. Crafts, Chicago.

TEXARKANA, TEX.—The Texarkana Telephone Company. $150,000. To construct and operate telephone lines in Arkansas, Louisiana, and Texas. W. P. Harrison, president.

ST. PAUL, MINN.—The Villard Telephone Company. $10,000. Incorporators: C. F. Angell, E. L. Scovelle, B. A. Angell, L. F. McGray, W. R. Burter, A. E. Clark and J. W. Burter.

NIAGARA FALLS, N. Y.—Niagara Falls & Lockport Railway Company. $200,000. Incorporators: Edward Michael, Clark L. Ingham, Buffalo; S. P. Franchot, and others, Niagara Falls.

BOGOTA, N. J.—Rio de Janeiro Telephone Company. $1,500,000. Incorporators: Charles H. Sisson, Bogota, N. J.; Isaac Gilbert, Jersey City; Frank H. Richmond, New York; Henry A. Robinson, Yonkers, N. Y.

STEWARTSVILLE, N. J.—The Stewartsville Telephone Company. $10,000. Incorporators: Benj. F. Strader, Michael E. Dowling, William Y. Rush, Frank W. Curtis, John W. Flynn, J. Ed. Weller, Samuel F. Schillinger, Stewart A. Schillinger, John C. Boyer, Harry E. Fry, John S. Stone, W. K. Thompson, Henry H. Stone, Stewartsville.

FORT RITTER, IND.—The Tri-County Fort Ritter Telephone Company. $5,000. Directors: Harvey Dixon, William P. Holland, Joseph P. Allen, Thomas Faris, Robert N. Flinn, Henry Woolery and W. H. Reed.

ST. LOUIS, MO.—The Farmers' Consolidated Telephone Company. $50,000. Incorporators: Hans Berger, N. J. Holmky, E. G. Emstevdt, Edward Paulson, Martin Strandford, O. E. Lernd and V. C. Peterson, of Sacred Heart.

LIVE OAK, FLA.—Live Oak & Perry Railway Company. $2,000,000. To build one hundred and sixty-five miles of railroad, from Jacksonville to St. Marks, passing through the counties of Duval, Baker, Columbia, Suwannee, Lafayette, Taylor, Jefferson and Wakulla.

ST. LOUIS, MO.—The Deerwood & Bay Lake Telephone Company. $3,000. Own and operate telephone lines between Deerwood and Bay Lake and other points within Crow Wing and Aitkin counties. Incorporators: A. N. Gray, David Archibald and A. A. Miller, of Bay Lake; H. J. Hege and O. C. Coffin, of Deerwood.

TELEPHONE AND TELEGRAPH.

MIDDLETOWN, N. Y.—Mayor Hornbeck, of Middletown, has vetoed the franchise granted by the common council to a new independent company, the Middletown Telephone Company.

LEE, MASS.—The Lee selectmen have refused the petition of the New England Telephone Company for pole locations in Centre street and in South Lee, and have reserved decision on the petition for poles in several other streets.

BOONVILLE, N. Y.—The Home Telephone Company, of Boonville, has bought the right of way and is putting up a line from North Gage Corners to Crooked Brook. It has shortened the route considerably, as the old line went out of the way to some extent.

HUNTINGDON, PA.—The Woodcock Valley Telephone Company has been chartered with a capital of $5,000. It is to build a line from Entrekin, Lincoln township, Huntingdon County, to Williamsburg, Porter township, Blair County. D. M. Summers, of Entrekin, is the treasurer.

HASTINGS, IOWA—The Mutual Telephone Company has the majority of its telephones installed, and is now ready to begin business. The exchange will be in connection with Emerson, Henderson and one line from the South immediately. Four or five more lines will be put in as soon as the farmers are over the busy season.

LINCOLN, NEB.—The Lincoln Telephone Company is improving its service by replacing its overhead single wires by compact cables. It expects by October 1 to do away entirely with single wires, and in their stead will be the cables which will enable it to do away with most of the cross-arms that make the poles so unsightly. This applies to practically all of the lines not now in underground conduits.

LOWVILLE, N. Y.—The Black River Telephone Company has completed the construction of an exchange line and a toll line from Lowville to New Bremen. The toll rate will be ten cents. The Central New York Telephone and Telegraph Company formerly had a toll station at a store in New Bremen, but since the destruction of the store by fire last spring there has been no telephone connection with New Bremen.

NAPLES, N. Y.—The Ontario & Steuben Telephone Company has elected new officers. A large amount of new stock has been taken and the lines have been extended in all directions. The officers are: president, William Waite, Atlanta; secretary, George A. Bolles, Naples; treasurer, W. H. Housel, Naples. These are ex-officio directors, and additional directors are D. D. Cottrell, North Cohocton; H. W. Blake, F. W. James and J. E. Lyons, Naples,

MILWAUKEE, WIS.—Two applications have been made to the city council for telephone franchises. One is by the West Shore Telephone and Telegraph Company and the second drawn up by Attorney E. H. Bottum at the request of Minneapolis capitalists

under the name of the Milwaukee Home Telephone Company. A hot fight is expected between the backers of the two propositions, as it is certain that the council will not grant franchises to both.

GRAND RAPIDS, MICH.—At the annual stockholders' meeting of the Citizens' Telephone Company it was voted to increase the capital stock from $2,000,000 to $3,000,000, the increase to be used solely for improvements to old properties and extensions of the business. The motion to increase was unanimously adopted. The old directorate was reelected and comprises C. F. Rood, E. B. Fisher, L. J. Rindge, Phillip Graham, J. B. Ware, G. W. Perkins, Edward Fitzgerald, C. E. Perkins, W. J. Stuart, E. G. Studley and R. D. Graham. The earnings for the year were given at $418,411.27 with expenses of $383,672.75, including dividends amounting to $139,551.63 during the year. There was carried to the surplus fund account $24,738.52.

SALT LAKE CITY, UTAH—The directors of the Rocky Mountain Bell Telephone Company have authorized the preparation of plans for and the immediate undertaking of some expensive improvements and alterations in the company's building on State street. The plans include the addition of two stories to the structure, making five in all, and the erection of a five-story addition seventy-seven feet long in the rear of the main building on land owned by the company. The completion of this work will give the Rocky Mountain Bell Telephone Company one of the largest buildings in the United States. Every inch of the space in the enlarged structure will be devoted to telephone purposes. So rapid has been the growth of the company's business during recent years that the shortage of room in the present building has become a severe handicap to the successful handling of the system. The additions will, it is believed, for the company will have a building five stories high and 170 feet deep, with a width of fifty feet, afford ample facilities for some years to come.

TROY, N. Y.—The Commercial Union Telephone Company, of Troy, has secured a controlling interest in the Cooperant Telephone Company, of Whitehall, and added these lines to its system, which now covers the entire eastern section of the state, as well as territory in adjoining states. Secretary and General Manager W. Levis Burk, of the Commercial Union company, completed the transaction at Whitehall recently by the purchase of a majority of the stock held locally. The Whitehall company, with other independent lines, has been working in cooperation with the Commercial Union company since it was organized. The Whitehall company has a capital stock of $50,000, and operates more than 1,200 telephones in a service covering the territory from Whitehall northward to Ticonderoga and eastward to Fair Haven, Hydeville, Castleton and Poultney. This system directly adjoins the territory already controlled by the Commercial Union company, which now extends from the Adirondacks to a point below Hudson. It is expected that an independent system in and about Poughkeepsie will soon be included.

PERSONAL MENTION.

MR. LAWRENCE CLEARE, for several years superintendent of the Bridgeport, Mass., electric light plant, has purchased a controlling interest in the company operating the system, the Bridgeport Electric Company.

MR. C. F. ANNETTE, chief of the bureau of communication for the Panama canal zone, has returned to New York after a five months' service in the field. Mr. Annette has had complete charge of the telephone and telegraph and other lines of communication.

MR. GEORGE HORNUNG, consulting engineer, of Cincinnati, Ohio, has been retained to design an entire new electric light plant for Reading, Ohio, to take the place of the present old plant. The entire system will be revised. New boilers, engines, generators, street lamps and line work will be required.

MR. C. L. BRAGG has been appointed manager of the Jacksonville, Fla., telephone exchange of the Southern Bell Telephone Company, succeeding Mr. L. G. Moore resigned. Mr. Bragg has been connected with the company at Tampa and other places for a number of years.

MR. E. E. HUNGERFORD, who for twenty-one years managed the Rome, N. Y., office of the Western Union Telegraph Company and who retired some eighteen months ago because of ill health, is again in charge of this office. Mr. J. P. Wooster returns to Auburn, where he will manage the company's office in that city.

MR. LEWIS H. BEAU has assumed the management of the Whatcom County Railway and Light Company's property in Bellingham, Wash., succeeding Mr. Francis E. Frothingham, resigned. Mr. Beau entered the service of Messrs. Stone & Webster seven years ago in Seattle, and has had a wide experience in street railway engineering.

MR. HOWARD M. POST, who has been made advertising manager of the Kellogg Switchboard and Supply Company, Chicago, Ill., has been connected with the engineering department of the company for the past four years. Before this he was with the Western Electric Company. Mr. Post has had a wide experience, not only as a constructing engineer, but as a designer and builder of telephone apparatus. In addition to his duties of advertising manager he will have full charge of all publicity of the company.

ELECTRICAL SECURITIES.

The market during the week remained fairly steady with little or no interest shown outside of profit taking at the end of the Saturday morning sessions and professional manipulation in general. Despite the lack of public interest, however, the outlook for trade is so good that buoyancy is the order of the day. The official confirmation, through the government August crop report, of the encouraging news concerning crops, has been sent out from various agricultural stations. It is no longer denied that the present and future business and financial outlook is such that there is every indication of a season of prosperity approaching, if not on a par with, the best which we have yet experienced.

The decision of the peace ambassadors from Russia and Japan to prolong the conference until every condition shall have been considered improves the possibility of peace as an outcome of their deliberations, and, of course, strengthens the foreign market, which can not but have a stimulating effect upon our own exchanges.

ELECTRICAL SECURITIES FOR THE WEEK ENDING AUGUST 12.

New York:	*Closing.*
Brooklyn Rapid Transit	69½
Consolidated Gas	190
General Electric	184
Interborough Rapid Transit	219
Kings County Electric	200
Manhattan Elevated	166¾
Metropolitan Street Railway	127¾
New York & New Jersey Telephone	168
Westinghouse Manufacturing Company	170½

While there was some buying in local tractions during the week prices remain about stationary. Interborough, however, made a substantial gain, with Manhattan Elevated and Metropolitan Street Railway improving a fraction of a point.

Boston:	*Closing.*
American Telephone and Telegraph	138¾
Edison Electric Illuminating	254
Massachusetts Electric	60
New England Telephone	138
Western Telephone and Telegraph preferred	99

The local market was quite active at the end of the week, Edison Electric Illuminating making a notable advance.

Philadelphia:	*Closing.*
Electric Company of America	11¾
Electric Storage Battery common	83
Electric Storage Battery preferred	83
Philadelphia Electric	8⅞
Philadelphia Rapid Transit	29
United Gas Improvement	99

Chicago:	*Closing.*
Chicago Telephone	135
Chicago Edison Light	155
Metropolitan Elevated preferred	64¾
National Carbon common	64
National Carbon preferred	115½
Union Traction common	30
Union Traction preferred	37

ELECTRIC RAILWAYS.

WHITESTONE, N. Y.—The Whitestone Association has decided to build a road with local capital. The road will cost about $75,000.

FREEPORT, ILL.—The Freeport Railway, Light and Power Company will install a 500-horse-power generator, to cost $10,000.

OTTAWA, ILL.—Work on the grading of the right of way for the interurban electric line between Princeton and Ladd will begin early in September.

EVERETT, WASH.—The city council has granted a franchise to the Rapid Railway Company which purposes to build a trolley road northward from Everett, Wash.

MUNCIE, IND.—It is reported that contracts will be let for grading the right of way for the new line of the Indianapolis, New Castle & Toledo Electric Railway Company.

MERIDEN, CT.—It is announced that construction will be started in the near future on the trolley road which is to connect Meriden and Cheshire. The charter was obtained two years ago.

EASTON, PA.—The Blue Ridge line, the State Belt line, both of which are operating over most of their right of way, and the interests represented by former Congressman Mutchler, of Easton, have signed an agreement to consolidate.

CHATTANOOGA, TENN.—J. H. Warner, president of the Chattanooga Electric Railway Company, has made official announcement that immediate work will be inaugurated on an extension of the Lookout mountain line of that system to the Georgia state line.

FRANKLIN, IND.—The Indianapolis, Hartford City & Celina Traction Company has been granted a fifty-year franchise by the town board at its last meeting. The ordinance granting this franchise requires that the proposed road be built and put in operation within one year.

LEXINGTON, KY.—The Central Kentucky Traction Company, which was organized a few months ago by local capitalists, has secured rights of way along the Richmond and Tates Creek pikes for the construction of an electric interurban railroad between Lexington and Richmond.

ELIZABETH CITY, N. C.—The Carolina Coast Railway Company has been organized to build from Norfolk to Beaufont. The officers are: president, W. B. Roper, of Norfolk; secretary, W. T. Harris, Norfolk; directors, W. B. Rodman, Thomas Duncan, W. B. Roper, W. T. Harris and W. C. Rodman.

WALNUT RIDGE, ARK.—The Walnut Ridge-Hoxie Light, Power and Transit Company will soon begin the work of extending the electric car line from the railroad crossing to the Young Men's Christian Association at Hoxie. There has been some talk of extending the line on to Cloverbent, or possibly Newport, in the near future.

ALTON, ILL.—The Alton, Jacksonville & Peoria Traction Company has a corps of engineers and surveyors and will begin surveying the right of way for the electric road which the company proposes to build from Alton to Peoria. The surveying party has started from Alton surveying north, and expects to complete the survey within forty days.

ELMIRA, N. Y.—The Elmira & Seneca Lake Railroad, the electric line sixteen miles in length connecting Seneca Lake, Watkins and Watkins Glen with Horseheads, the northern terminus of the lines of the Elmira Water, Light and Railroad Company, has been purchased by the Lackawanna Railroad Company and will be operated by that company.

HACKENSACK, N. J.—It is announced that within the next few weeks work will be commenced on the trolley road of the State Line Traction Company. This concern proposes to extend the line of the Public Service Corporation in North Paterson to Ridgewood before the fall, and it is the ultimate intention of the company to extend its system to the New York state line, touching Hohokus, and then running to Greenwood Lake.

PATERSON, N. J.—The project to build a trolley line to Greenwood Lake is again agitated. The line is to start at Singac and go through Wayne, Mountain View, Pompton Plains and Pompton, where a branch will run to Butler, four miles distant. The main line will continue from Pompton to Midvale and Hewitt, past Coopers, the Lakeside and the Ferncliffe, in Orange County. The line, according to the plan, would be about twenty-five miles long.

RUTLAND, VT.—United States Circuit Judge Hoyt H. Wheeler, at Brattleboro, has appointed General Manager David Fox, of the Rutland Street Railway Company and allied concerns, of Rutland, receiver. This is the result of the petition of Douglass Robinson, receiver of the Merchants' Trust Company, of New York, in which Vermont concerns are heavily bonded. The receivership will not affect the operation of the plants at present.

BOSTON, MASS.—According to the present plans of the Boston Elevated Railway, work on the extension from Dudley street to Forest Hills will be begun early in September. The first work will be the installation of the cement foundations on which will rest the upright supports of steel. Already these foundations have been laid as far as Townsend street, this work having been done some two years ago, soon after the elevated road began to be operated.

NEW WILMINGTON, OHIO—An effort is being made to have the Shenango Valley Traction Company build a branch to New Wilmington, the home of Westminster College. It is reported on good authority that the company will go from Pulaski across country to New Castle, and enter the latter named place on the line of the old coal road and down Highland avenue. As this will bring the line within three miles of the college town an effort will be made to have a branch built.

LIMA, OHIO—Contractor Cliff T. Wise, of Lima, has closed an agreement for the construction of thirty-six miles of trolley road paralleling the Lake Erie & Western steam line between Muncie and Portland, Ind., to be completed by October 1, for the McCullogh syndicate, of Indiana roads. This will leave but a gap of twenty-six miles to connect with the Western Ohio at Celina, Ohio, plans for which link are now being entertained by Cleveland capitalists.

EVANSVILLE, IND.—The county commissioners of Vanderburg County have granted a right of way to the Evansville & Mount Vernon traction line to the Posey County boundary line. The company has thirty months in which to build the road. The Evansville & Newburgh Suburban Traction Company will run its Boonville branch to Woodmere and cut out Newburgh. Passengers coming from Boonville desiring to reach Newburgh will make connection with the main line at Woodmere.

FRANKLIN, IND.—The board of county commissioners of Johnson County has granted a franchise to the Indianapolis & Ohio Valley Traction Company, which purposes to build from Indianapolis to Evansville. The company is to obtain a private right of way through Johnson County and is not to charge more than one and three-quarters cents a mile. Work is to begin by May 1, 1906, and the line is to be in operation between Indianapolis and Nashville, Ind., by May 1, 1908.

BOSTON, MASS.—The Uxbridge & Blackstone Street Railway Company has been authorized to issue additional capital stock amounting to $40,000, the proceeds to be used for paying indebtedness incurred in constructing and equipping the company's electric railway between Whitins and Millville, Mass., *via* Uxbridge, a distance of seven miles. The company's previous issue of stock amounts to $80,000 and it has a funded debt of $80,000. It began operating its road September 1, 1902.

SOUTHINGTON, CT.—The trolley link which the Connecticut Railway and Lighting Company has been building between Cheshire and Milldale is practically completed. A car containing the officials of the company has been run over the line and at an early date the line will be formerly inspected by the railroad commissioners. After their certificate of approval has been secured a regular service will be established. It is expected that the road will be in operation within ten days.

NIAGARA FALLS, N. Y.—The Niagara Falls & Lockport Electric Railway Company has been incorporated with a capital of $200,000 to build a road connecting by the most direct trolley route Niagara Falls and Lockport. The proposed line will be about

twenty miles long. The directors include a number of well-known Buffalo men, *viz.:* Edward Michael, Clark L. Ingham, W. D. Ingham, and John M. Bradford, also S. P. Franchot, William P. Baker and James S. Simmons, of Niagara Falls.

OWOSSO, MICH.—G. H. Stephenson, of Philadelphia, and J. D. Leland, of Durand, have been granted a franchise for a street railway through Owosso by the village council. The said road is to be built and in operation by December 1, 1906, and is a continuance of and will be part of the Owosso and Corunna present electric street railway now in operation at the above places. The road will also be built to Durand and when completed there will be about ten miles of track of said road.

WAYNESBORO, PA.—The Hagerstown & Waynesboro Electric Street Railway Company has been organized at Waynesboro with the following directors: J. A. Strite, Esq., Chambersburg; Jacob S. Lesher and W. T. Omwake, Waynesboro; John W. Feldman, Hagerstown; W. A. Morgart and Roderick Clary, Cumberland, Md. Mr. Morgart was chosen president and Mr. Clary treasurer. The capital stock is $25,000. The company will build to state line and has three ways by which it can enter Waynesboro.

OKLAHOMA CITY, O. T.—Dyke Ballinger, of Anadarko, is cited as authority for the statement that an electric railroad will be built from Oklahoma City to Anadarko *via* Chickasha. This is supposed to be a part of the proposition under way for some time, of building a line connecting Anadarko, Chickasha, El Reno and several other western cities with Oklahoma City. It is said that a survey of a portion of the route has been completed and Chicago parties are reported as being interested in the project.

LANCASTER, PA.—A company has been organized by Lancaster County capitalists to build a trolley line, six miles long, between Mount Joy and Elizabethtown. The line will be built on the Harrisburg turnpike. Rheems and Florin will be touched by the road. A new trolley road between Lancaster and Mount Joy is half completed. When the six-mile extension road to Elizabethtown is built there will be but three miles more interval to Conewago, the southern terminus of the Cornwall & Lebanon Railroad.

HARTFORD, CT.—At the annual meeting of the Hartford & Springfield Street Railway Company directors and officers were elected and it was voted to purchase the Rockville, Broad Brook & East Windsor street railway at once. Those elected were: directors, William A. Tucker, Boston; Chauncey Eldridge, Boston; John C. Rice, Boston; Henry S. Newton, Enfield; Lewis Sperry, South Windsor; Francis R. Cooley and Arthur Perkins, Hartford; officers, president, William A. Tucker; secretary, Arthur Perkins; treasurer, Chauncey Eldridge; superintendent, Henry S. Newton.

PITTSBURG, PA.—Charters have been granted for seven new lines of passenger railways in the Sewickley valley, with a total of $100,000 capital, or $6,000 a mile. The charters are as follows: the Ambridge, Edgeworth & Sewickley; Ambridge, Sewickley & Osborne; Ambridge, Dixmont & Emsworth; Ambridge, Osborne & Haysville; Ambridge, Haysville & Glenfield; Ambridge, Glenfield & Dixmont; Ambridge, Leetsdale & Edgeworth. The incorporators for all these companies are D. O. Black, W. H. Keech, W. D. Allison, E. B. Wilson and J. N. Jarvis. The united lines will be about sixteen miles in length.

BOONVILLE, IND.—At a meeting of the city council a franchise was granted the Evansville, Suburban & Newburg Electric Railway in the city of Boonville. The franchise gives the company the right to extend its line to the public square and to select one of two routes, coming in either from the north or south. It also gives the company the right to carry passengers and express by electricity and freight by steam. It was stated by the representatives of the company that work will be commenced on the new line from Woodmere to Boonville as soon as the right of way is complete, and that cars will be running by January.

MARYSVILLE, COL.—The survey of the route for the electric road which will run between Grass Valley and Auburn has been completed between these two points and the surveyors will now turn their attention toward the line leading into Marysville, commencing at the lime kiln, where the Marysville road leaves the Auburn road. Two bridges will be necessary between Grass Valley and Auburn, but they will not be expensive ones. The rights of way have been secured in nearly every instance, and the work of construction depends upon the way in which the farmers between Marysville and Grass Valley treat the company in the way of rights of way.

SHAWNEE, O. T.—The Oklahoma Electric Railway Company, with $250,000 capital, has been incorporated for the purpose of building an electric line from Tecumseh to connect with the Shawnee Traction Company's lines in Shawnee. The money for the line has been subscribed, and Alfred Hare, a Tecumseh banker, president of the new corporation, is in the East securing the material. A large amount of money will be used in fitting up a great amusement park on the North Canadian river, between the Santa Fe shops and Tecumseh. The new line will unite into one the city of Shawnee, with its 20,000 people, and Tecumseh, with 7,000 more, the two towns being nearly united now.

HARTFORD, CT.—The Shaw interests of Boston, by which the Boston & Worcester street railway is operated, will begin work within the next thirty days upon the construction of the Hartford & Worcester Street Railway, which will run by what is nearly a straight line between these two cities. The new road will be a continuation of the Boston & Worcester, and will be backed and operated by the same interests, although under a different corporation name. Upon the completion of the new road it is thought probable that the two will be merged. The Hartford & Worcester road will run through a promising territory, ensuring financial success, and it will furnish the Boston & Worcester road with a tremendous feeding territory. It is planned to run a direct branch from East Brimfield into Springfield by way of Monson.

ATLANTA, GA.—An electric line will be constructed in the near future which will more closely connect Macon with Atlanta, a charter having been granted to the Atlanta-Macon Interurban Railway Company. The charter was granted to Thomas B. Felder, of Atlanta; Charles J. Canfield, of Chicago; George W. Swigart, W. H. Turnbull and C. C. Young, of Manistee, Mich.; J. Albert Johnson, of Greenwood, Ind.; William F. Wacher, of Indianapolis, Ind.; Grafton Johnson, of Greenwood, Ind.; James B. Nelson, of Greenwood, Ind.; George H. Williamson, of Atlanta. The capital stock of the company is $100,000, divided into 1,000 shares of $100 each. The route from Atlanta is in a southeasterly direction through Fulton, Clay, Henry, Spalding, Pike, Monroe and Bibb counties. The road will run through Jonesboro, Hampton, Griffin, Barnesville and Forsyth.

SCRANTON, PA.—Ninety per cent of the stock of the Scranton, Factoryville & Tunkhannock Electric Railway Company has been acquired by the Northern Electric Railway Company and a trolley road from Scranton to Tunkhannock by way of Factoryville is assured. There will be a spur of the road running from Glenburn and lake Winola, a beautiful body of water twenty miles from Scranton. The roads were chartered virtually for the same territory and each has secured valuable rights of way. These rights will be combined and the most feasible selected. The president of the Tunkhannock company is James P. Dickson, of Scranton. The officers of the Northern company are Dr. A. J. Connell, president; E. H. Ripple, secretary and treasurer; T. J. Foster, Scranton; R. B. Day, Wilkesbarre; E. L. Fuller, Long Island; H. A. Connell and the Hon. W. L. Connell, of Scranton, directors. The distance to be covered by the projected road is about thirty-five miles.

PITTSBURG, PA.—Arrangements have been made by H. P. Taylor & Company, of Pittsburg, for the underwriting of $400,000 of an issue of $1,000,000 of bonds of the Erie, Cambridge, Union & Corry Railway Company, and the contract for the construction of the line has been awarded to the Bessemer Construction Company, of Pittsburg. It is expected that the road will be completed early next spring. The new electric line will be forty-two miles long and will run from Erie, on lake Erie, through Langdon, Godard and Samson to Waterford, where a "Y" is formed. One branch extends southwest through Mill village and Millers station to Cambridge Springs, the famous summer resort of northwestern Pennsylvania. Another branch runs southeast from Waterford through Le Boeuf, Union City, Elgin and Louell to Corry. The line is being built on private right of way, with T-rails, and it is estimated that the run from Erie to Cambridge Springs will be made in one hour. Each car will be equipped with four fifty-horse-power motors, capable of operating the car at a speed of forty miles an hour.

INDUSTRIAL ITEMS.

THE WESTINGHOUSE TRACTION BRAKE COMPANY, Pittsburg, Pa., has distributed a data-sheet for type D, form EG, size No. 3, gear-driven, direct-current, motor-driven air compressor.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Ct., is calling attention to its fuseless rosettes in a neat flyer. These rosettes are easily and quickly installed. They are furnished in three styles—cleat, concealed and moulding. Samples will be sent upon application.

G. M. GEST, the expert subway contractor, of New York and Cincinnati, has been awarded a contract for the construction of an additional subway to the present system of the Cincinnati Bell Telephone Company, at Cincinnati, Ohio. The work is to be completed so that it can be used before bad weather sets in.

THE EDISON ELECTRIC ILLUMINATING COMPANY, Boston, Mass., in "Edison Light" for August illustrates the coal-conveying and distributing appliances at the L street station of the company. In addition there is the customary sprightly literature concerning the attractiveness and usefulness of electric service.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., reports having closed contracts for switchboards for the following places: Kansas City, Mo.; Decatur, Ala.; Boise, Creighton, Neb.; Unadilla, N. Y.; Maquoketa, Ohio; Granite, Minn.; Charity, Mo.; Greenville, Ohio; Crystal, N. D.

L. B. ALLEN COMPANY, INCORPORATED, Chicago, Ill., manufacturer of the Allen soldering specialties and commutator lubricant, has opened an office in New York city, at 97-98 Warren street. The company will be ably represented by Mr. A. Hall Berry, who will give prompt and courteous attention to all enquiries.

MASON'S GAS POWER COMPANY, LIMITED, Levensholme, Manchester, England, has issued an elaborate catalogue describing its methods of supplying producer gas for engines and furnaces. This company builds plants to make producer gas for furnace work, gas engines and builds the Duff patent gas producer, the Whitfield patent gas producer, the Weardale patent gas-fired furnace.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., has struck a happy idea in advertising. This takes the form of a souvenir postal-card, having a picture in colors of its Iowa salesman, Mr. W. R. Hind, with the salutation, "I Am Waiting for Your Orders." This post-card is decidedly attractive, and has been the means of stirring up numbers of enquiries and orders.

THE WALLACE BARNES COMPANY, Bristol, Ct., has issued a handsome catalogue of the products it manufactures. This includes small springs of every description, and the company also deals in wire and cold rolled steel. In addition to the matter descriptive and illustrative of the company's materials there are considerable data relating to the mechanics and physics of the subject.

THE ATWATER KENT MANUFACTURING WORKS, Philadelphia, Pa., manufacturer of ignition specialties, formerly located at 112 North Sixth street, is now located in its new home, a modern, fireproof building, at 42, 44 and 46 North Sixth street, where it has considerably larger floor space than in its old location, and the facilities for increasing to a great extent the output of the ignition specialties which it manufactures.

THE AITON MACHINE COMPANY, 126 Liberty street, New York city, in bulletin No. 32 describes and illustrates its new six-drum strands. The drums are carried in steel cradles and have the new tension or endless rope as preferred. The cradles are connected by cranks to an eccentric ring for keeping torsion out of the wires. The cradles are carried on a strong hollow centre-shaft, having a stationary cold-drawn tube in it. The shaft is mounted at the rear in a pillow block, and carries a roller head on its front end running between four rollers. The machine is driven from the front and can be used as a separate unit or in tandem with others.

THE MORGAN CONSTRUCTION COMPANY, Worcester, Mass., in a comprehensive and well-illustrated catalogue, entitled "Morgan Continuous Gas Producer," sets the merits of this producer forth, together with much instructive information regarding the process itself and economies obtainable by its use as the most modern means of securing the highest heating value of fuel. An average efficiency of ninety-two per cent is shown in tests made by Robert W. Hunt & Company at the works of the Grand Crossing Track Company. This remarkable result speaks well for the progress that has been made in perfecting an automatic producer. Views are shown of large installations. The catalogue contains fifty six by nine pages with a handsome embossed cover. The New York office of the company is at 40 Exchange place.

THE B. F. STURTEVANT COMPANY, Boston, Mass., is making a decided novelty in the way of an economizer installation for the American Steel and Wire Company Consolidated Works, Cleveland, Ohio. This equipment of 5,000-horse-power capacity, to be used in connection with billet heating furnaces, is the first installation of this kind ever made in America. The metal-to-metal joint of the Sturtevant economizer is capable of withstanding the high gas temperature, and the staggered arrangement of the pipes in the Sturtevant economizer presents an advantage by breaking up the volume of gases and compelling the particles to come in close contact with the entire heating surface.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has recently secured a number of orders through its foreign department which indicates the great activity in electrical lines in the Far East. The following orders are of interest: Mitsui & Company, Tokio, Japan, have purchased one three-phase, revolving-field, 200-kilowatt, sixty-cycle, 2,300-volt generator; one 110-volt, seven-kilowatt, direct-current marine generating set with switchboard. Another order for the Kosaka Copper Mines, Japan, consists of one motor-generator, consisting of a 100-horse-power, 3,120-volt induction motor, direct-connected to a seventy-five-kilowatt, 550-volt, direct-current generator. In addition to the above for Japan a recent order includes twenty-eight miles of single-conductor, lead-covered wires of various sizes, and twenty-two miles of stranded lead-covered cables of various sizes. Australian orders include six GE, fifty-eight double-motor railway equipments for the Perth electric tramways, and one ten-kilowatt, one sixteen-kilowatt and one twenty-four-kilowatt storage battery booster sets for the New Zealand Electric Construction Company. The Siam Electricity Company, Bangkok, Siam, has purchased a 500-kilowatt, 550-volt, direct-current, two-stage Curtis steam turbine alternator, several direct-current pump motors and a switchboard. South African orders include two 500-kilowatt, three-phase, 2,300-volt, Curtis steam turbine-alternator sets and one 450-horse-power, 2,080-volt, two-speed induction motor for Robinson Deep Mine; one 1,000-kilowatt, 3,300-volt, three-phase Curtis turbo-alternator sets and sixteen 200-volt induction motors aggregating 115 horse-power for the Consolidated Gold Fields, of South Africa, Limited. In addition to the above for the Far East, Brazilian orders come from South America, as follows: five two-motor GE fifty-eight equipments with B13 controllers and electric brake for Jardin Botanico, Rio de Janeiro. Eleven 440-volt induction motors aggregating 220 horse-power, forty type H transformers aggregating 400 kilowatts with switchboard equipment for Mococa, Brazil. The Rio de Janeiro Tramway, Light and Power Company, Brazil, has purchased a 200-kilowatt, fifty-cycle testing transformer with 150,000 volts as maximum, stepping up from 216 volts primary, and there have been ordered from Manaos, Brazil, two 150-horse-power, 550-volt, direct-current motors and one 400-kilowatt, 575-volt, direct-current generator for direct-connection to a Harrisburg engine.

EDUCATIONAL.

THE WORCESTER POLYTECHNIC INSTITUTE is adding to its present power plant. The machinery to be added consists of a 200-horse-power boiler and a compound engine rated at 175 horse-power, and directly connected to a sixty-cycle Westinghouse revolving field alternator, with a complete switchboard. During the college year it has anticipated that a small direct-connected unit of about sixty horse-power will be added, and the plans already adopted call for a second 200-horse-power boiler and a 250-horse-power direct-connected steam unit. The new machine is being added to supply power and light for the institute, and it is hoped that it will leave the old equipment free for educational purposes.